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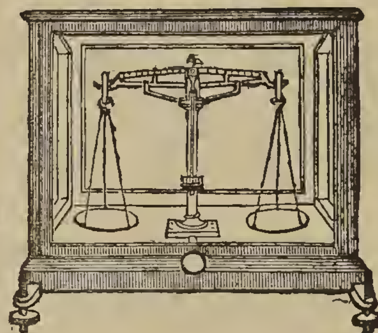

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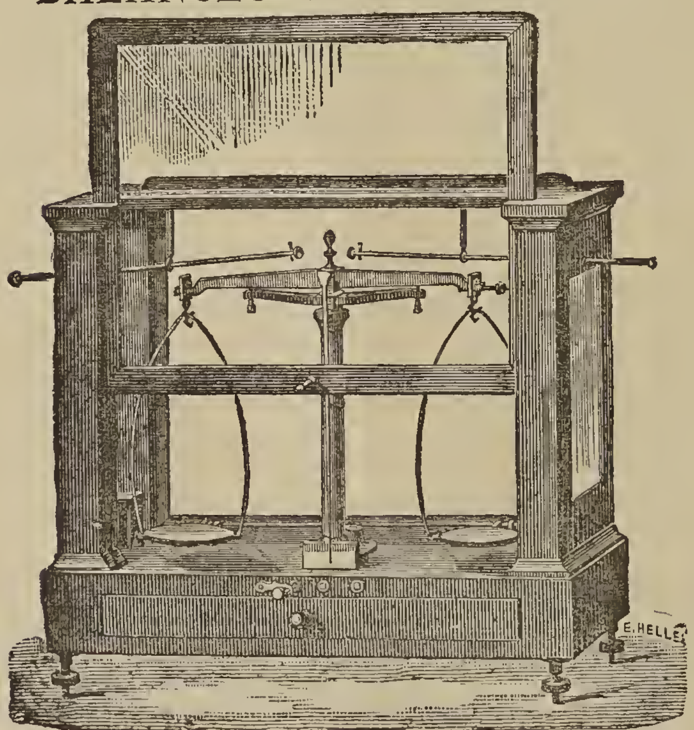

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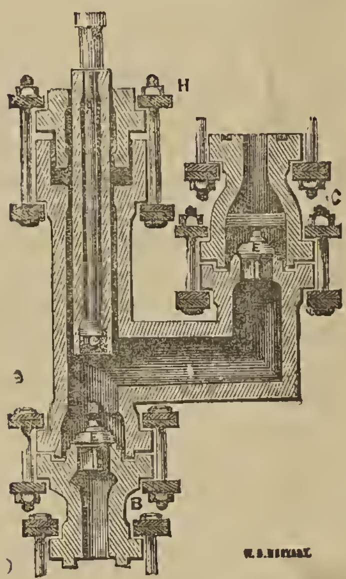

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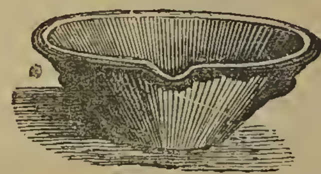

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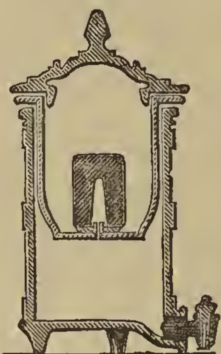

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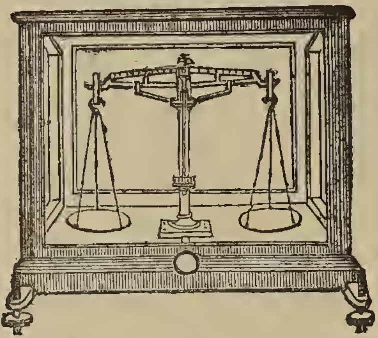

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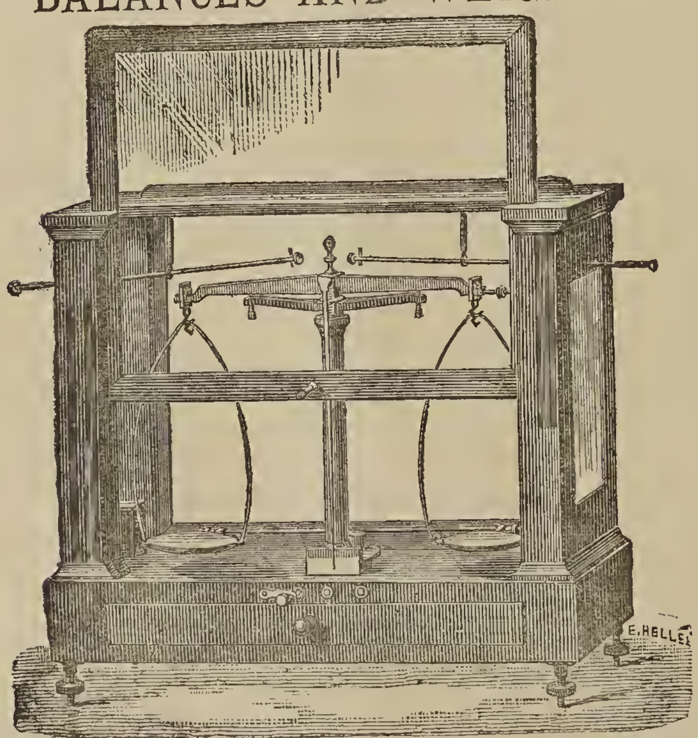

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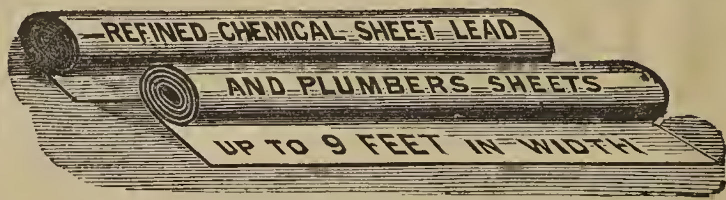

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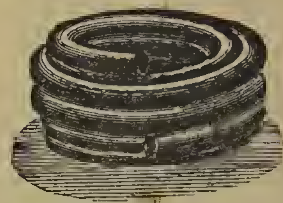

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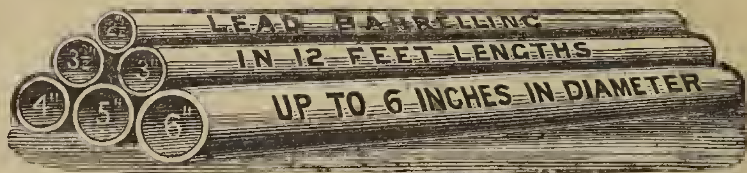

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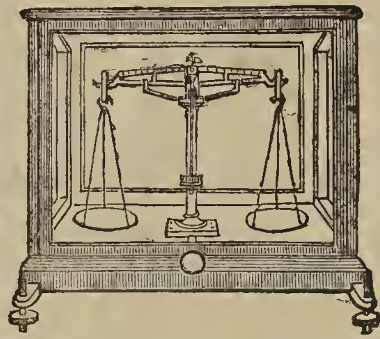

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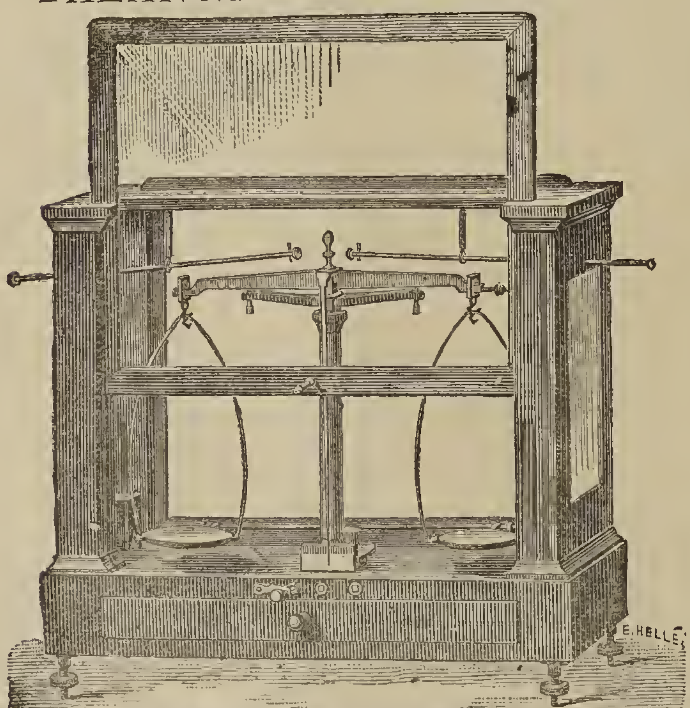

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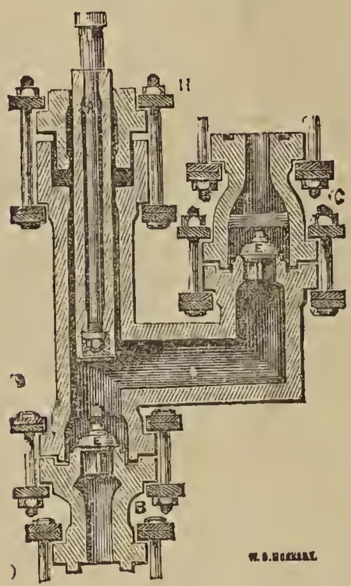

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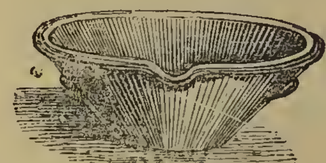

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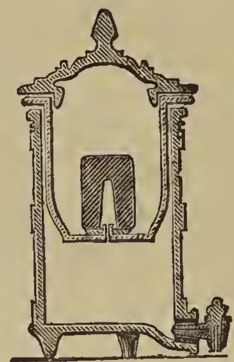

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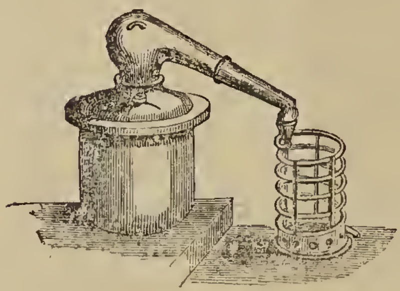

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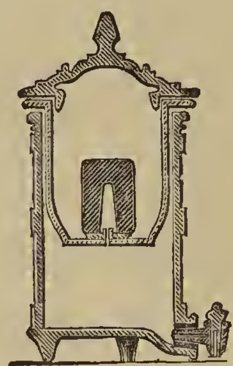

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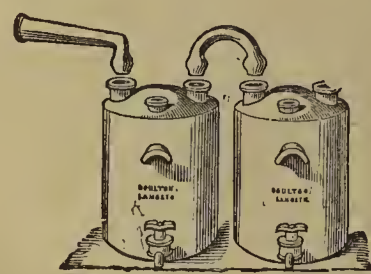

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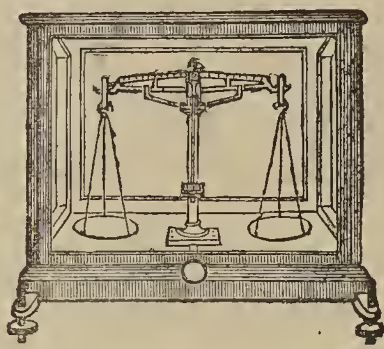

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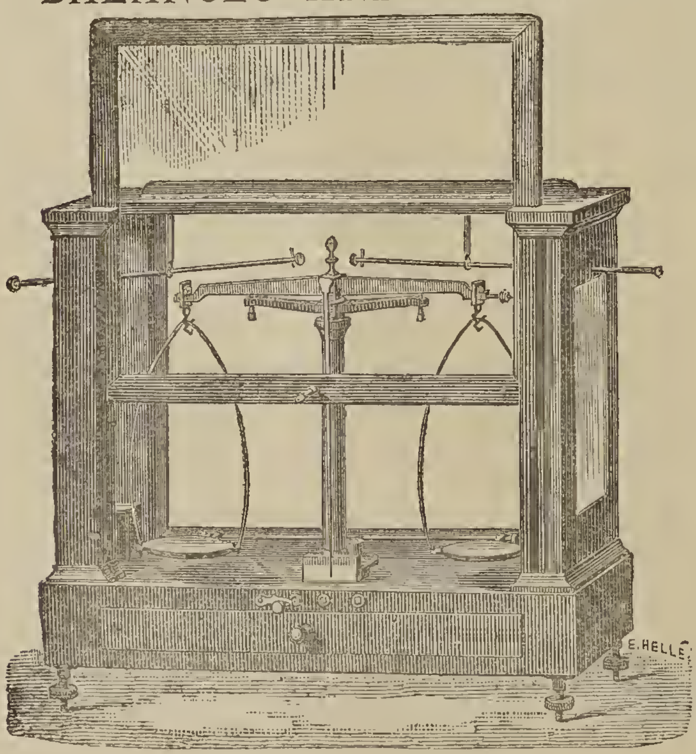

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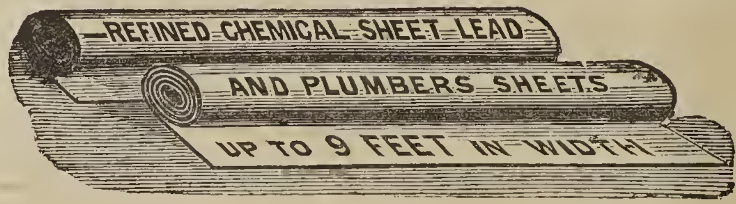

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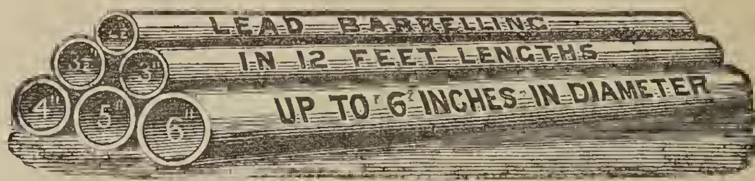

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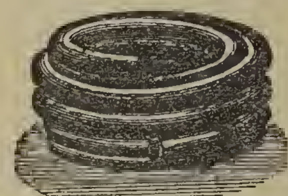

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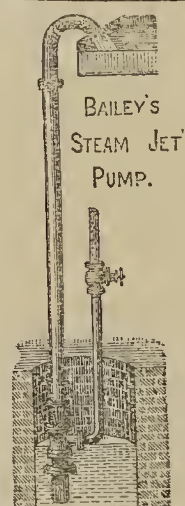

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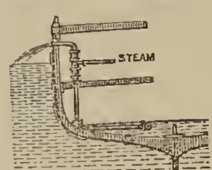

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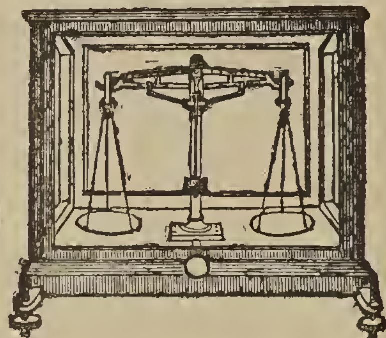

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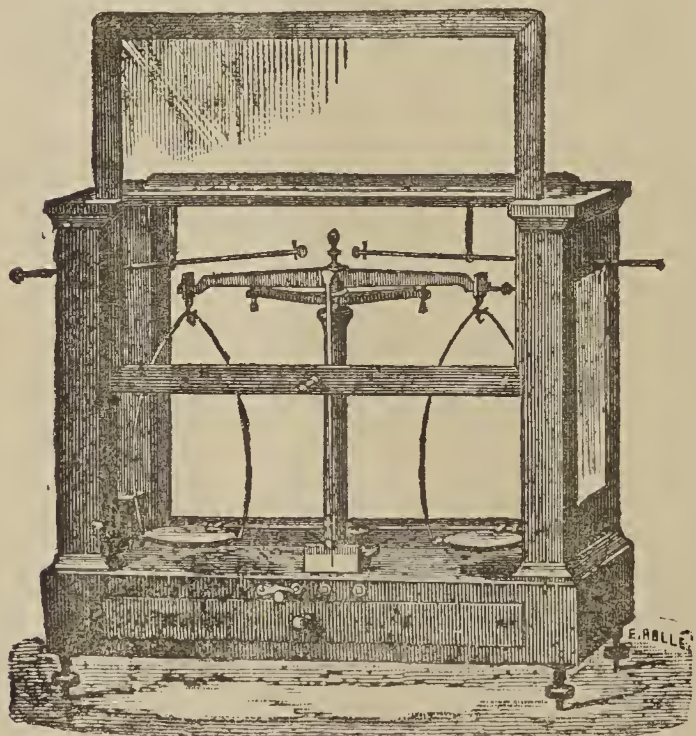

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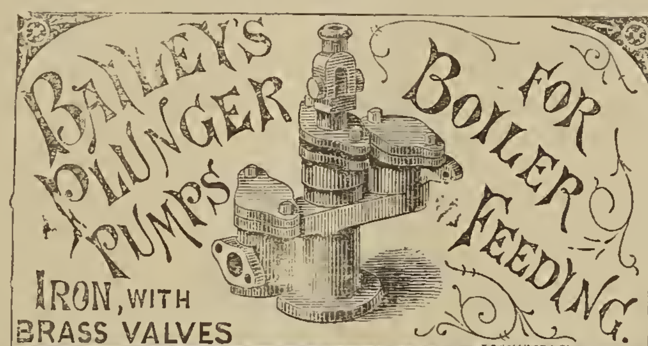

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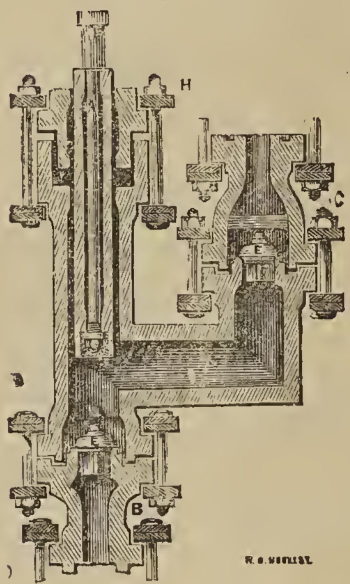

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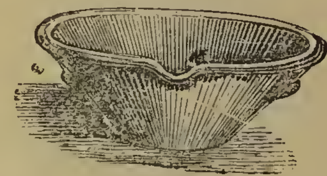

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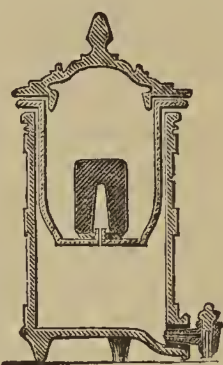

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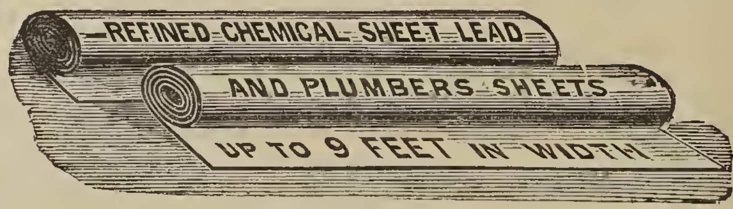

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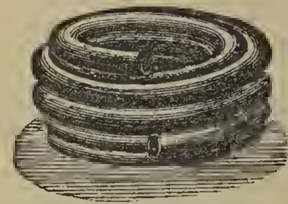

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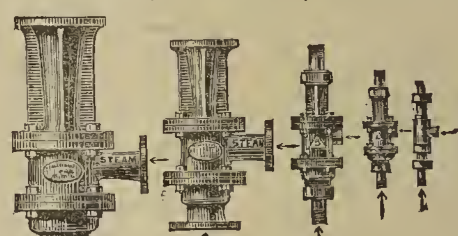

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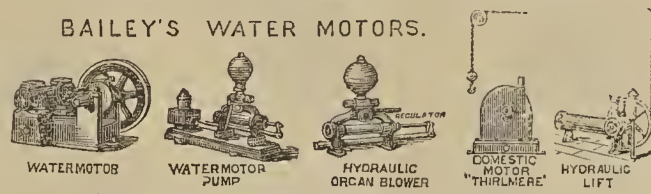

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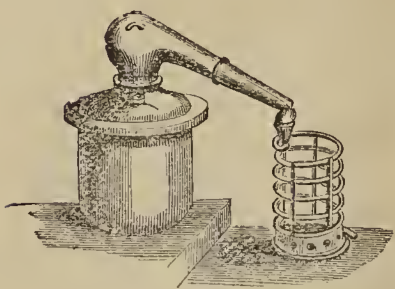

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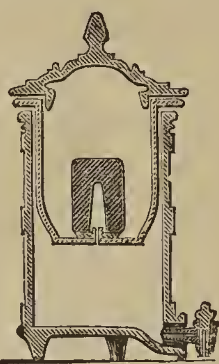

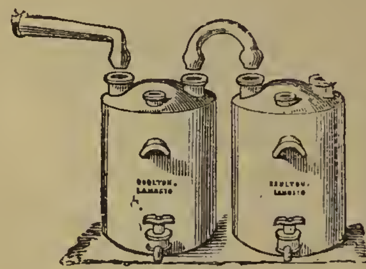

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THE

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AND

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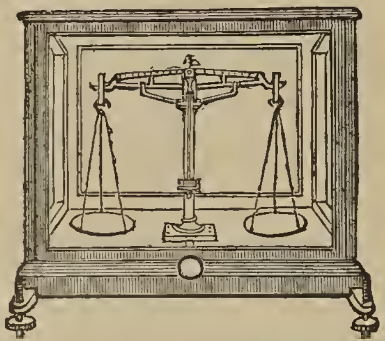

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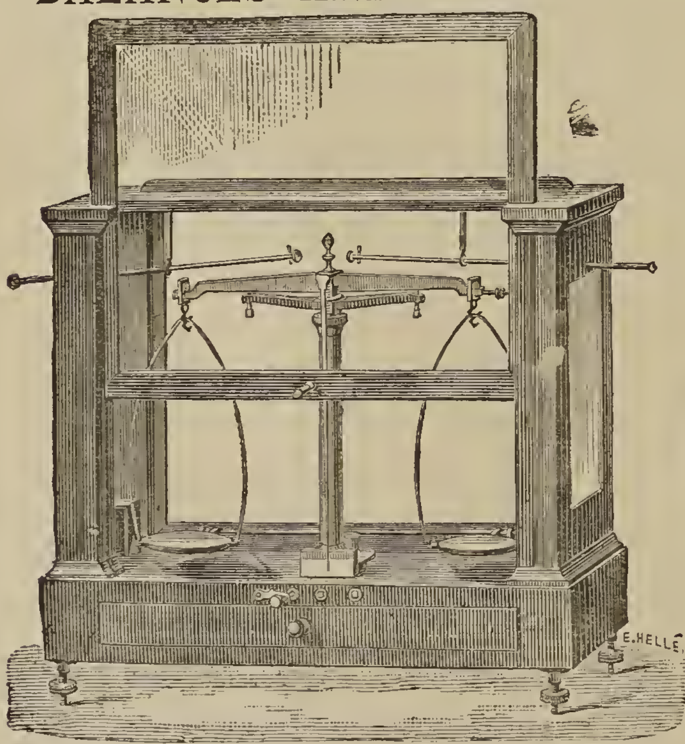

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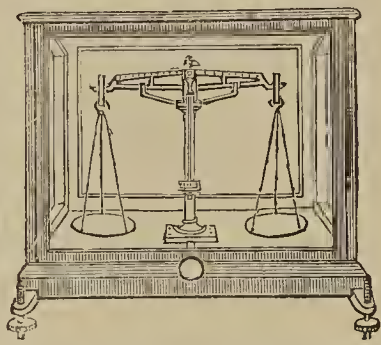

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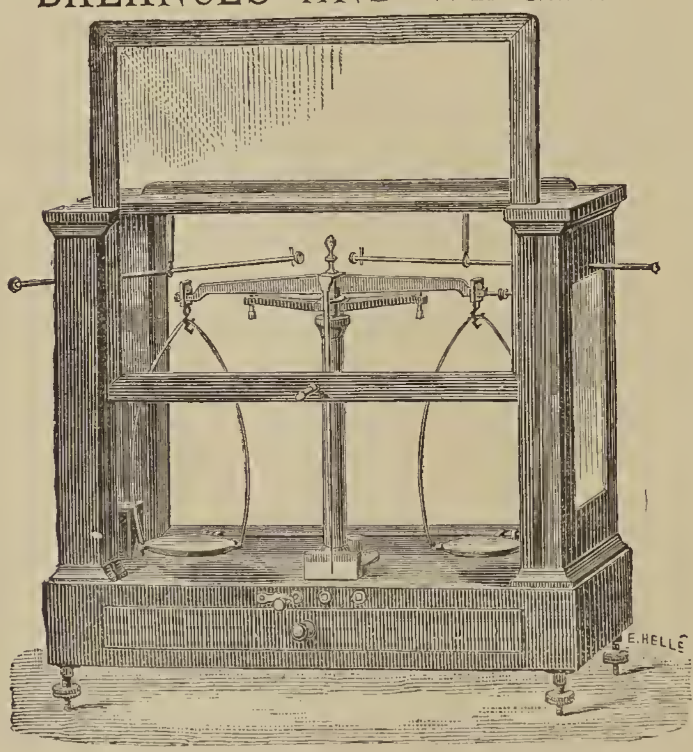

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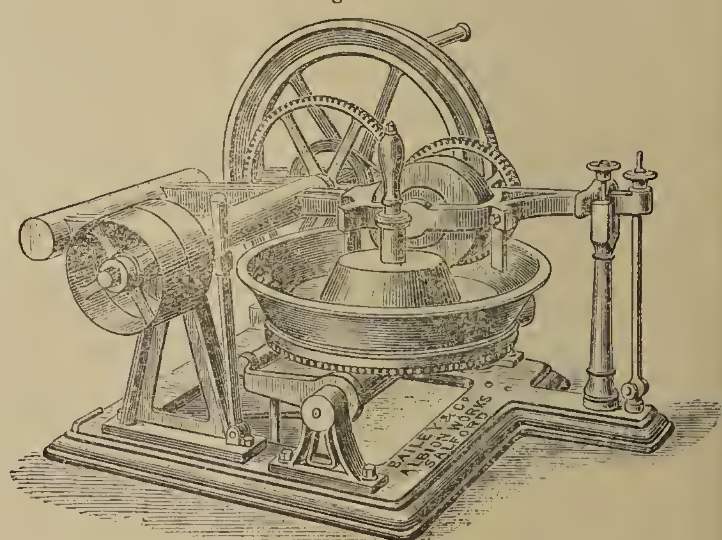

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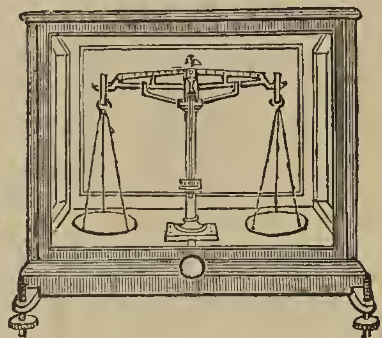

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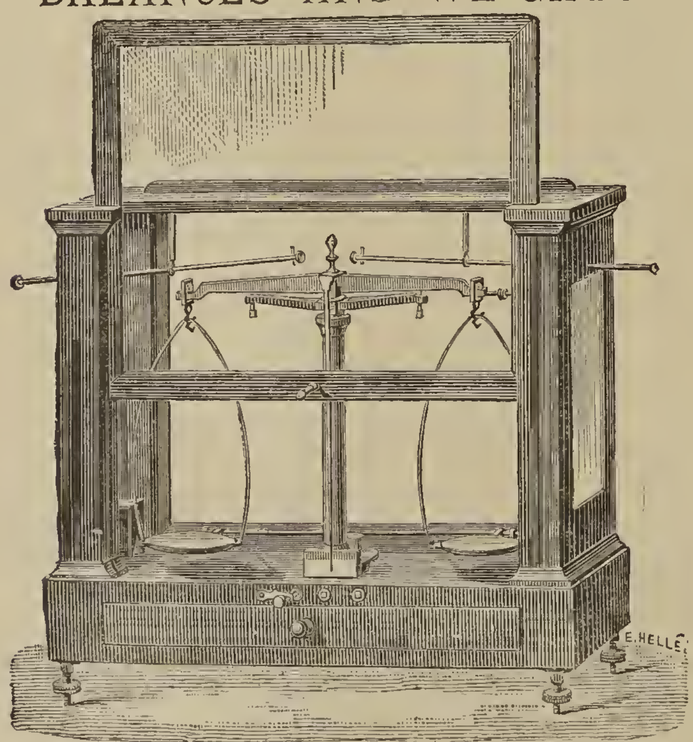

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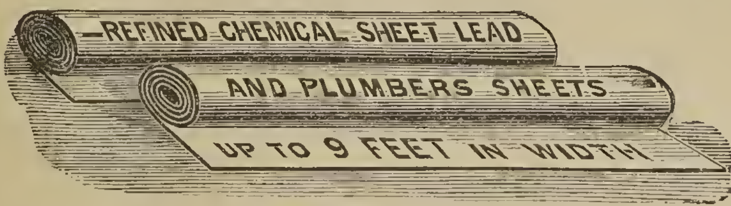

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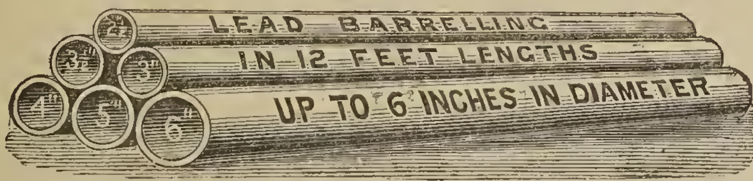

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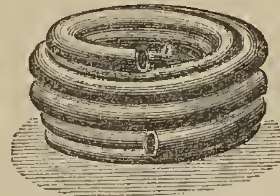

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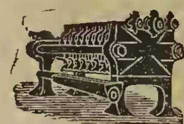


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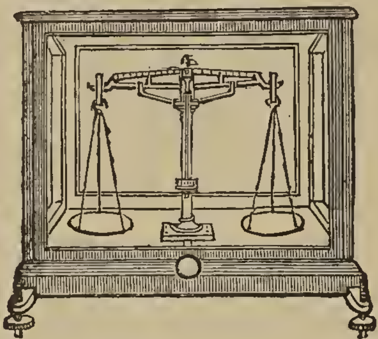

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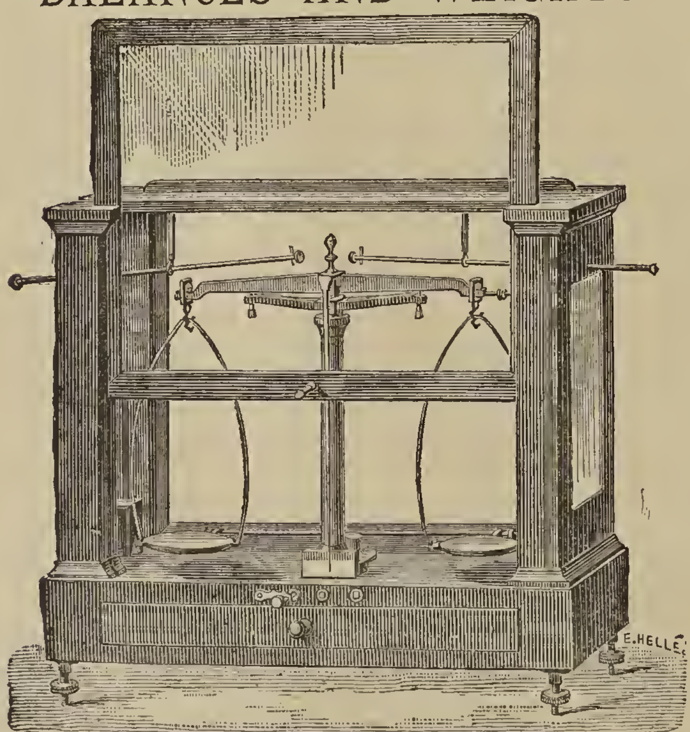

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CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE

Edited by Wm. Crookes, F.R.S.] (WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE") [Established Thirty-Eight Years.

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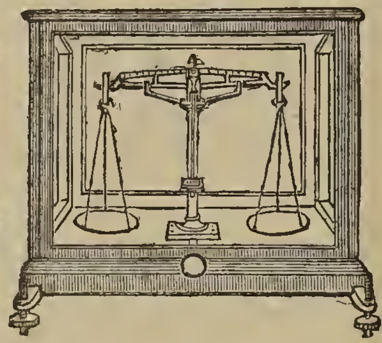

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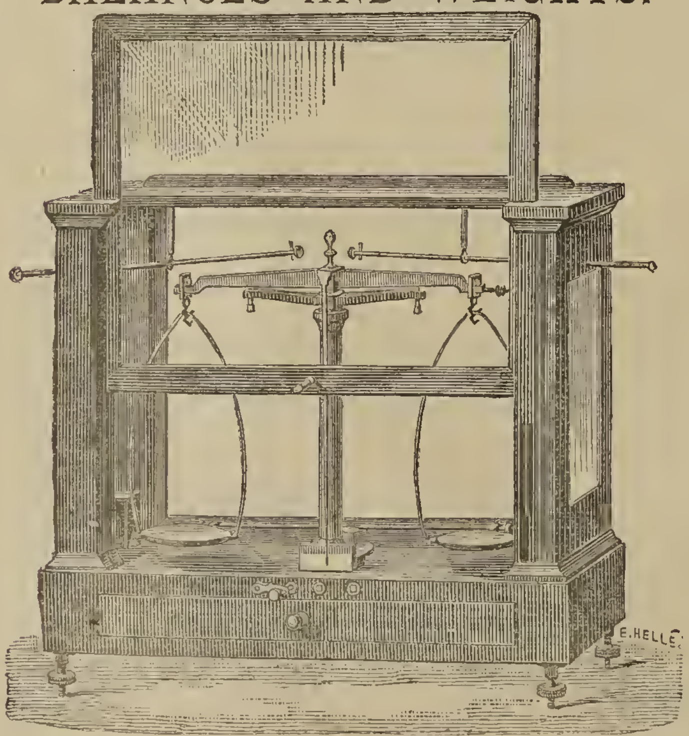

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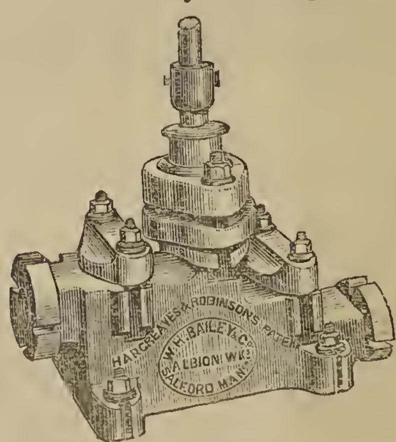

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THE CHEMICAL NEWS.

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EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1258.—JANUARY 4, 1884.

PECULIAR ABSORPTION OF A COMPOUND OF IODINE BY ALUMINIUM.*

By Dr. G. GORE F.R.S.

A PIECE of clean sheet aluminium 2½ inches long and 2 inches wide, and weighing about 20 grains, was divided into two equal portions:—One of them, together with a sheet of platinum, was immersed in a colourless solution of 17½ grains of pure iodic acid in 3½ ounces of water, so as to form a voltaic pair, and the other was wholly immersed in a similar portion of the same liquid in a separate and similar glass vessel, and both were kept at the atmospheric temperature. The current from the voltaic couple was passed by means of a small silver anode, and a much smaller silver cathode, through a plating solution of argentic cyanide containing the minimum practical amount of free cyanide of potassium in order to obtain the maximum amount of silver deposit.

The plates were immersed three hours. During that period, gas was evolved in moderate quantity from each aluminium plate, but none visibly from the platinum one. An electric current was produced, and silver freely deposited. The liquids gradually became strongly coloured by liberated iodine, and apparently to the same extent.

At the end of the above period, the aluminium plates and the silver cathode were taken out. Each of the former plates had become very rough and corroded in vertical grooves through the influence of the ascending streams of gas, but no deposit of iodine or oxide appeared upon them; their surfaces were metallic and bright. The three plates were thoroughly washed in cold water, dried between sheets of hot filter-paper, and weighed. During the washing iodine came freely out of the aluminium ones, but no alumina was visible. The weight of silver deposited was 1·30 grains, equal to 0·110 grain of the positive aluminium plate dissolved to produce the current, and to 2·03 grains of iodine liberated by the hydrogen set free at the platinum plate.

Notwithstanding that the plates were both of them evidently much corroded, the positive one being probably the most so, and that much iodine had been extracted from each plate by the process of washing, they had each gained in weight 1·30 grain. By further repeated immersion alternately in cold and in boiling water, the gain of weight of each was reduced to 1·10 grain. The dry plates were then immersed in bisulphide of carbon in a closed vessel during 36 hours at 16° C., but not a trace of colour was produced in the liquid. After evaporation of the bisulphide by exposure to the air, the plates still emitted an odour of iodine.

A sheet of aluminium was also immersed during fourteen hours in a cold saturated solution of iodine in water, No corrosion of the metal took place, and no signs of absorption of iodine were observable. The absorption in the previous experiments was therefore probably due to the action of hydrogen setting free nascent iodine at the absorbing surface.

A sheet of aluminium was freely corroded in dilute hydrochloric acid, containing dissolved iodine, during one and a half hour, but no iodine was absorbed.

A solution of iodine in dilute sulphuric acid was slowly electrolysed during three hours by a current from two cells of zinc and platinum in that dilute acid, with electrodes of sheet aluminium. Gas was evolved; most at the cathode. No iodine was absorbed.

A colourless solution of potassic iodide was electrolysed during the same time in the same manner. Gas was set free, chiefly at the cathode. The liquid remained colourless. A very small amount of iodine was absorbed by the anode.

A colourless solution of potassic iodate was similarly treated during two hours. The liquid around the cathode became immediately coloured with iodine, and after a time that around the anode also became slightly coloured. The anode lost 0·041 grain in weight, and the cathode 0·126 grain. The anode alone absorbed a minute amount of iodine.

An equivalent quantity of bromate of barium, in fine powder, was mixed with some dilute sulphuric acid, and allowed to digest, with occasional stirring, during nineteen hours. A sheet of aluminium was then immersed in the clear liquid; hydrogen was evolved; bromine was set free and coloured the liquid, but the application of various tests revealed only feeble signs of bromine having been absorbed by the metal.

In another experiment, a sheet of the metal, two inches long and two inches wide, and weighing 15·752 grains, was immersed during about three hours in five ounces of water containing 25·749 grains of dry iodic acid, the solution being at about 16° C. Much gas was evolved, the metal gained 1·273 grain in weight, and evolved a strong odour of iodine. It was then completely dissolved in hot dilute hydrochloric acid, and the amount of metal in the solution determined by means of ammonic chloride and ammonia in the usual manner. The amount of aluminium thus found was 14·685 grain. The quantity of metal therefore which had dissolved in the solution of iodic acid was 1·066 grains, and the amount of substance, apparently iodine only, absorbed by the remaining 14·685 grains of metal, was 2·340 grains, or 15·93 per cent of its weight.

* Read before the Birmingham Philosophical Society, December 13th, 1883.

A thin sheet of the metal became very slightly corroded by immersion during five hours in a mixture of dilute sulphuric acid, and a solution of potassic iodide, but showed no signs of absorption.

In dilute aqueous hydriodic acid containing dissolved iodine, the metal was rapidly corroded, but in two hours had only absorbed a trace of iodine. The sheets were, however, disintegrated. By fracturing them the odour of iodine was much more distinct. By enclosing the sheets either wet or dry in corked glass tubes during twenty-four hours, the odour was not increased.

By examining under a microscope, a sheet which had been immersed in the aqueous iodic acid, it was found to be partly disintegrated into thin layers.

These various results point towards the inference, that the absorption of the iodine compound occurred when that substance was set free in the nascent state at the corroding surface of the aluminium. The case appears to be somewhat similar to that of absorption of nascent hydrogen by palladium.

A thin and straight sheet of aluminium, coated on one side with shellac, and caused to absorb the maximum amount of iodine in the manner already described, did not become curved.

A chemical analysis of the absorbed substance has not yet been made.

ON THE CONSTITUTION OF CHLOROPHYLL.*

By EDWARD SCHUNCK, F.R.S.

An examination of some products derived from chlorophyll, which has occupied me for some time, has led to the question of the true nature and constitution of chlorophyll, a question on which widely different opinions prevail. Without entering into matters which concern the physiologist only, it may be said that to the chemist chlorophyll is simply an organic colouring-matter, the substance to which the green colour of leaves and other parts of plants is due. Now colouring-matters are of three kinds. To the first class belong such as occur ready formed and in a free state in vegetable and animal organisms, such as the colouring-matters of turmeric and safflower. The second class comprises those that are formed from colourless chromogens by the combined action of alkalies and oxygen, the colouring-matters of logwood and archil being well-known examples of this class. These colouring-matters change rapidly when exposed to the further action of oxygen in the presence of alkali, but are quite stable when in contact with acids. The third class consists of glucosides, bodies which do not undergo any considerable change under the influence of alkalies, but are rapidly decomposed when acted on by acids or ferments, yielding, on the one hand, some kind of glucose, and, on the other, substances in which the tinctorial properties of the parent substance are much more pronounced. To this division belong the colouring-matters of madder, quercitron, cochineal, &c. Now chlorophyll in its general properties so much resembles the members of the last class that one cannot help suspecting that to this class it may belong—that it is, in fact, a glucoside. It shows considerable stability in the presence of alkalies, but acids decompose it rapidly, giving rise to substances which are intensely coloured and show a power of absorbing particular parts of the spectrum much more strongly than chlorophyll itself. Whether, along with the latter bodies, it yields by decomposition with acids some kind of glucose seemed to me a question worthy of attention.

If it was possible to obtain chlorophyll in a state of purity it would be very easy to settle this question; unfortunately all attempts hitherto made to separate and purify chlorophyll have ended in its decomposition. I consider it as certain that the so-called crystallised chlorophyll which has been described by several authors is in fact a derivative of chlorophyll formed during the process employed for preparing it. It is, however, very easy to obtain a solution of chlorophyll which shall be quite free from everything soluble in water extracted at the same time from the plant, and therefore free from ready-formed glucose. In order to effect this I proceed as follows:— Having extracted leaves of any kind with boiling alcohol, I allow the extract to stand for some time, filter off the deposit which usually forms, and then mix it with its own volume of ether and with about two volumes of water, shaking up well. The liquid now separates into two layers, an upper green one, containing all the chlorophyll of the extract, and a lower bright yellow one, which contains tannin, a yellow colouring-matter, a substance giving the glucose reaction with Fehling's solution, and probably other substances besides. The two liquids are separated in the usual way, and the upper one is shaken up with fresh water, which now usually only shows a trace of colour. This process of washing may be repeated, adding each time a little fresh ether, until the lower layer ceases to give the glucose reaction. The upper liquid leaves on spontaneous evaporation a bright green residue, which, though far from being pure chlorophyll, is free from everything soluble in water, and may therefore be employed to determine whether anything soluble in water, such as glucose, is formed by the action of acids on it. If some of the residue be treated with concentrated sulphuric acid in the cold it dissolves, forming a green solution, which, after standing for some time, gives, on the addition of water, a dark green precipitate. This precipitate consists essentially of two substances, the phyllocyanin and phylloxanthin of Frémy, which are undoubtedly products derived from chlorophyll, showing the absorption-bands of what is usually called "acid chlorophyll." The liquid filtered from this precipitate, when mixed with copper sulphate and an excess of caustic alkali, becomes blue, and the mixture, on boiling, deposits cuprous oxide. The experiment may be made in a slightly different manner. The residue left by the green ethereal solution of chlorophyll having been dissolved in alcohol, sulphuric or hydrochloric acid is added to the solution, which is then boiled for some time, evaporated so far as to drive off most of the alcohol, filtered from the products insoluble in water, made alkaline, then mixed with Fehling's solution and boiled, when the usual glucose reaction takes place. In order to make sure that the reaction was not due to ready-formed glucose, I took in every case the precaution of testing a portion of the green chlorophyllic residue with Fehling's solution before acting on the rest with acid. This was easily done by treating with weak alcohol, to which a little alcoholic potash and some Fehling's solution were added, and heating, when the whole dissolved easily, giving a green solution, which, on boiling, in no case deposited the least trace of cuprous oxide, whereas, after adding an excess of hydrochloric acid to the liquid, boiling, filtering off the insoluble products, again making alkaline and boiling, the glucose reaction took place in a marked manner.

This experiment has never in any case failed, and it would follow, if uniformly successful, that the green leaves of all plants contain a glucoside insoluble in water, but soluble in alcohol and ether. That this glucoside is, in fact, chlorophyll seems to me highly probable. Nevertheless, absolute certainty cannot be attained, because the matter experimented on is a mixture, and it is possible that one plant out of many might give a decidedly negative result, which would upset the conclusion drawn from the rest. Assuming, however, that the phenomena will always occur as above described, and that the reaction with Fehling's solution indicates the presence of some kind of glucose, it would follow either that chlorophyll is a glucoside or that it is always accompanied in the vegetable cell by a glucoside of very similar properties.

I may add that I attempted to isolate the glucose or glucose-like substance formed under the circumstances

* A Paper read before the Royal Society, Dec. 20th, 1883.

described, spinach leaves being the material employed, and obtained a pale yellow gum-like substance which showed no tendency to assume a crystalline form.

ON THE
PRESENCE OF BARIUM AND STONTIUM IN A BOILER INCRUSTATION.

By C. L. BLOXAM.

A very hard crust removed from a kitchen boiler was found to contain, in addition to the calcium carbonate, sulphate, and silicate usually found in these deposits, a notable proportion of barium and strontium sulphates. The barium sulphate obtained from 100 grains of the incrustation was not worth weighing, but the strontium sulphate weighed 1·54 grains, representing 0·73 per cent of strontium.

The water from which the deposit was formed was derived from a deep well in the chalk at Harrow. It was remarkably bright and clear, and contained (grains per gallon) 14·48 SO_3, 8·88 Cl, 7·21 CaO (including the BaO and SrO), 5·61 MgO, 15·20 Na_2O (including a little K_2O and Li_2O), 12·60 CO_2 (combined), 1·28 SiO_2.

As the demand for strontia is increasing, through the introduction of the new process of extracting sugar, it is desirable that chemists should be on the look-out for it. In order to determine the strontium, the crust was treated with HCl, evaporated to dryness, the residue extracted with water, which left SiO_2, $CaSO_4$, $BaSO_4$, $SrSO_4$, sand and clay undissolved.

This residue was digested for two or three hours with a strong solution of Na_2CO_3, which dissolved the SiO_2 and converted the sulphates into carbonates. These were dissolved in HCl, filtered from the sand and clay, the solution neutralised with NH_3, acidified with $HC_2H_3O_2$, and mixed with $K_2Cr_2O_7$, which caused a slight precipitate of $BaCrO_4$. After twelve hours standing this was filtered off, and the diluted filtrate precipitated with H_2SO_4. After filtering off the $SrSO_4$, no further deposit occurred in the filtrate for many hours, after which the $CaSO_4$ began to crystallise.

The $SrSO_4$ was identified by digesting in Na_2CO_3, dissolving the $SrCO_3$ in HCl, and gently evaporating, when the long needles of strontium chloride were obtained. Both the barium and strontium precipitates were verified by the spectroscope.

The qualitative analysis of the crust was performed upon 1000 grains, from which a crop of crystals, over an inch length, of strontium chloride was obtained.

King's College, London,
December 27, 1883.

THE ESTIMATION OF CHLORINE, BROMINE, AND IODINE IN PRESENCE OF ONE ANOTHER.

By F. MAXWELL-LYTE.

In the Chemical News (vol. xlviii., p. 284) is a paper by Paul Julius on the "Decomposition of Silver Chloride by Bromine, and of Silver Bromide by Iodine." Doubtless these experiments were made by him with a view to the separation of chlorine, bromine, and iodine from one another. In this connection the following will be found a convenient method :—

The haloids having been precipitated together with silver, the precipitate is to be collected, dried, and weighed.

It is now dissolved in about thirty or forty times its weight of water by the addition of the least possible quantity of cyanide of potassium. A quantity of pure bromide of potassium is now added, which need not be above the weight of the precipitate. The cyanide is now decomposed by the addition of an excess of dilute sulphuric acid.

The precipitate, in which any silver chloride has become by this means converted into silver bromide, is now collected on a filter, dried, and weighed.

It is once more dissolved by the least possible quantity of potassium cyanide, and the same quantity of water, and to this is now added one and a quarter times the original weight of the precipitate of potassium iodide.

The cyanide is now again decomposed by dilute sulphuric acid, and the precipitate once more collected on a filter, dried, and weighed.

In this last precipitate all the silver is converted into iodide, excepting such as was iodide already. In the second experiment all became bromide, excepting such as was bromide or iodide already.

From the weights then obtained from the first, second, and third weighings the chlorine, bromine, and iodine may easily be calculated. I use this plan, dissolving in cyanide, as I find sometimes that the addition of a soluble iodide or bromide may not suffice to decompose completely the bromide or iodide respectively. The cyanide used may be the ordinary commercial cyanide, *providing always*, as is usually the case, it be free from any trace of iodide.

Cotford, Oakhill Rd., Putney, SW.,
December 26, 1883.

SOME SPECIFIC GRAVITY DETERMINATIONS

By F. W. CLARKE.

The following specific gravity determinations were made under my supervision by the students named below. The salts were weighed in benzene, and the density of water at 4 degrees was taken as unity. Each figure is the mean of several closely concordant results.

Uranyl sulphate, $(UO_2)SO_4.3H_2O$, 3·280 at 16·5°. H. Schmidt.

Uranyl ammonium sulphate, $(UO_2)Am_2(SO_4)_2.2H_2O$, 3·0131 at 21·5°. H. Schmidt.

Uranyl potassium sulphate $(UO_2)K_2(SO_4)_2.2H_2O$, 3·363 at 19·1°. H. Schmidt.

Double salt, $K_2CrO_4.2Hg(CN)_2$, 3·564 at 21·8°. H. Schmidt.

Ferric chloride sublimed, Fe_2Cl_6, 2·804 at 10·8°. J. P. Grabfield.

Ferrous chloride, $FeCl_2$, 2·988 at 17·9°. J. P. Grabfield.

Chromic chloride, violet, Cr_2Cl_6, 2·757 at 15°. J. P. Crabfield.

Chromous chloride, $CrCl_2$, 2·751 at 14°. J. P. Grabfield.

The last compound contained 14 per cent of chromic oxide as an impurity, and the sp. gr. actually found was 3·067. This, corrected by means of Schröder's value for Cr_2O_3, 5·01, gives the sp. gr. assigned above.

Strontium chloride, cryst., $SrCl_2.6H_2O$, 1·964, 16·7°. E. Muehlberg.

Cadmium chloride, $CdCl_2$, 3·655, 16·9°. P. A. Knight.

Cadmium bromide, $CdBr_2$, 4·794, 19·9°. P. A. Knight.

Cadmium fluoride, CdF_2, 5·994, 22·0°. E. A. Kebler.

Thallium iodide, precipitated, TlI, 7·072, 15·5°. E. Twitchell.

Thallium iodide, after fusion, TlI, 7·0975, 14·7°. E. Twitchell.

Thallium bromide, precipitated, TlBr, 7·540, 21·7°. H. Keck.

Thallium bromide, after fusion, TlBr, 7·557, 17·3°. H. Keck.

Lead bromide, precipitated, $PbBr_2$, 6·572, 19·2°. H. Keck.

Silver tartrantimonite, $SbAgC_4H_4O_7$, 3·4805, 18·2°. C. S. Evans.

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A RECALCULATION OF THE ATOMIC WEIGHTS.*

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MAGNESIUM.

There is perhaps no common metal of which the atomic weight has been subjected to closer scrutiny than that of magnesium. The value is low, and its determination should, therefore, be relatively free from many of the ordinary sources of error; it is extensively applied in chemical analysis, and ought consequently to be accurately ascertained. Strange discrepancies, however, exist between the results obtained by different investigators; so that the generally accepted figure cannot be regarded as absolutely free from doubt.

The determinations of Berzelius† and other early chemists need not be here considered. Nor does the estimation made by Macdonnell‡ deserve more than a passing mention. He puts the atomic weight of magnesium at 23·9, but gives no details concerning his method of determination. The researches which we have to consider are those of Scheerer, Svanberg and Nordenfeldt, Jacquelain, Bahr, Marchand and Scheerer, and Dumas.

Scheerer's method of investigation was exceedingly simple.‖ He merely estimated the sulphuric acid in anhydrous magnesium sulphate, employing the usual process of precipitation as barium sulphate. He gives no weighings, but reports the percentages of SO_3 thus found. In his calculations, $O=100$, $SO_3=500·75$, and $BaO=955·29$. It is easy, therefore, to re-calculate the figures which he gives, so as to establish what his method really represents, viz., the ratio between the sulphates of barium and magnesium.

Thus revised, his four analyses show that 100 parts of $MgSO_4$ yield the following quantities of $BaSO_4$:—

	Per cent SO_3.
193·575	66·573
193·677	66·608
193·767	66·639
193·631	66·592

Mean 193·6625 $\pm$ 0·0274

Hence, using the atomic weights deduced in previous chapters for Ba, S, and O, $Mg=24·544 \pm 0·0311$. In a subsequent note§ Scheerer shows that the barium sulphate of the foregoing experiments carried down with it magnesium salts in such quantity as to make the atomic weight of magnesium 0·39 too low. Corrected, Mg becomes $=24·545$.

The work of Bahr, of Jacquelain, and in part that of Svanberg and Nordenfeldt, also relates to the composition of magnesium sulphate. Jacquelain's experiments were as follows.¶ Dry magnesium sulphate was prepared by mixing the ordinary hydrous salt to a paste with sulphuric scid, and calcining the mass in a platinum crucible over a spirit-lamp to constant weight and complete neutrality of reaction. This dry sulphate was weighed and intensely ignited three successive times. The weight of the residual MgO having been determined, it was moistened with sulphuric acid and re-calcined over a spirit-lamp, thus reproducing the original weight of $MgSO_4$. Jacquelain's weighings for these two experiments show that 100 parts of MgO correspond to the quantities of $MgSO_4$ given in the last column:—

1·466 grm. $MgSO_4$ gave 0·492 grm. MgO.	297·968
0·492 „ MgO „ 1·466 „ $MgSO_4$.	297·968

Jacquelain also made one estimation of sulphuric acid in the foregoing sulphate as $BaSO_4$. His result (1·464 grm. $MgSO_4=2·838$ grms. $BaSO_4$) reduced to the standard adopted in dealing with Scheerer's experiments, give for 100 parts of $MgSO_4$, 193·852 $BaSO_4$. If this figure be given equal weight with a single experiment in Scheerer's series, and combined with the latter, the mean will be $193·700 \pm 0·0331$. From this the atomic weight of magnesium becomes $24·244 \pm 0·033$. This again, corrected according to Scheerer for the magnesium salts carried down by the barium sulphate, becomes 0·39 higher, or $Mg=24·283$. Of course this correction, determined by Scheerer for a single experiment, can only be a rough approximation in a mean like the foregoing. It is better than no correction at all, the character of the error involved being known.

Bahr's* work resembles in part that of Jacquelain. This chemist converted pure magnesium oxide into sulphate, and from the increase in weight determined the composition of the latter salt. From his weighings 100 parts of MgO equal the amounts of $MgSO_4$ given in the third column:—

1·6938 MgO gave	5·0157 grms. $MgSO_4$.	296·122
2·0459 „	6·0648 „	296·437
1·0784 „	3·1925 „	296·040

Mean 296·200 $\pm$ 0·0815

About four years previous to the investigations of Bahr the paper of Svanberg and Nordenfeldt† appeared. These chemists started with the oxalate of magnesium, which was dried at a temperature of from 100 to 105° until it no longer lost weight. The salt then contained two molecules of water, and upon strong ignition it left a residue of MgO. The percentage of MgO in the oxalate comes out as follows:—

7·2634 grms. oxalate gave	1·9872 oxide.	27·359 per cent.
6·3795 „	1·7464 „	27·359 „
6·3653 „	1·7418 „	27·364 „
6·2216 „	1·7027 „	27·368 „

Mean 27·3665 $\pm$ 0·0023

In three of these experiments the MgO was treated with H_2SO_4, and converted, as by Jacquelain and by Bahr in their later researches, into $MgSO_4$. 100 parts of MgO gave of $MgSO_4$ as follows:—

1·9872 grm. MgO gave	5·8995 $MgSO_4$.	296·875
1·7464 „	5·1783 „	296·513
1·7418 „	5·1666 „	296·624

Mean 296·671 $\pm$ 0·072

We have now for this ratio between MgO and $MgSO_4$ three series; not at all concordant. We may combine them, assigning to each of Jacquelain's two results a weight corresponding to one of Bahr's:—

Jacquelain	297·968	$\pm$ 0·0999
Bahr	296·200	0·0815
Svanberg and Nordenfeldt	296·671	0·072
General mean	296·806	0·0475

In 1850 the elaborate investigations of Marchand and Scheerer‡ appeared. These chemists undertook to determine the composition of some natural magnesites, and, by applying corrections for impurities, to deduce from their results the sought for atomic weight. The magnesite chosen for the investigation was, first, a yellow, transparent variety from Snarum; second, a white opaque mineral from the same locality; and, third, a very pure

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Lehrbuch*, 5 Aufl., Bd. 3, s. 1227.
‡ *British Association Report.* 1852, part 2, p. 36.
‖ *Poggend. Annal.*, 69, 535. 1846.
§ *Poggend. Annal.*, 70, 407.
¶ *Ann. d. Chem. et Phys.*, 3 serie, 32, 202.

* *Journ. f. Prakt. Chemie*, 56, 310. 1852.
† *Ibid.*, 45, 473. 1848.
‡ *Ibid.*, 50, 385.

quality from Frankenstein. In each case the impurities were carefully determined; but only a part of the details need be cited here. Silica was of course easily corrected for by simple subtraction from the sum of all of the constituents; but iron and calcium, when found, having been present in the mineral as carbonates, required the assignment to them of a portion of the carbonic acid. In the atomic weight determinations the mineral was first dried at 300°. The loss in weight upon ignition was then carbon dioxide. It was found, however, that even here a correction was necessary. Magnesite, upon drying at 300°, loses a trace of CO_2, and still retains a little water; on the other hand, a minute quantity of CO_2 remains even after ignition. The CO_2 expelled at 300° amounted in one experiment to 0·054 per cent; that retained after calcination to 0·055 per cent. Both errors tend in the same direction, and increase the apparent percentage of MgO in the magnesite. On the yellow mineral from Snarum the crude results are as follows, giving percentages of MgO, FeO, and CO_2 after eliminating silica:—

CO_2.	MgO.	FeO.
51·8958	47·3278	0·7764
51·8798	47·3393	0·7809
51·8734	47·3154	0·8112
51·8875	47·3372	0·7753
	Mean 47·3299 ± 0·0037	

After applying corrections for loss and retention of CO_2 as previously indicated, the mean results of the foregoing series become—

CO_2.	MgO.	FeO.
51·9931	47·2743	0·7860

The ratio between the MgO and the CO_2, after correcting for the iron, will be considered further on.

Of the white magnesite from Snarum but a single analysis was made, which, for present purposes, may be ignored. Concerning the Frankenstein mineral three series of analyses were executed. In the first series the following results were obtained:—

8·996 grms. CO_2 =	8·2245 grms. MgO.	47·760 pr. ct. MgO.
7·960 ,,	7·2775 ,,	47·761 ,,
9·3265 ,,	8·529 ,,	47·767 ,,
7·553 ,,	6·9095 ,,	47·775 ,,
	Mean	47·766 ± 0·0022

This mean, corrected for loss of CO_2 in drying, becomes 47·681. I give series second with corrections applied:—

6·8195 $MgCO_3$ gave	3·2500 grms. MgO.	47·658 per cent.
11·3061 ,,	5·3849 ,,	47·628 ,,
9·7375 ,,	4·635 ,,	47·599 ,,
12·3887 ,,	5·9033 ,,	47·650 ,,
32·4148 ,,	15·453 ,,	47·674 ,,
38·8912 ,,	18·5366 ,,	47·663 ,,
26·5223 ,,	12·6445 ,,	47·675 ,,
	Mean	47·650 ± 0·0069

The third series was made upon very pure material, so that the corrections, although applied, were less influential. The results were as follows:—

4·2913 $MgCO_3$ gave	2·0436 grms. MgO.	47·622
27·8286 ,,	13·2539 ,,	47·627
14·6192 ,,	6·9692 ,,	47·672
18·3085 ,,	8·7237 ,,	47·648
	Mean	47·642 ± 0·0077

In a supplementary paper* by Scheerer, it was shown that an important correction to the foregoing data had been overlooked. Scheerer, re-examining the magnesites in question, discovered in them traces of lime, which had escaped notice in the original analyses. With this correction the two magnesites in question exhibit the following mean composition:—

	Snarum.	Frankenstein.
CO_2	52·131	52·338
MgO	46·663	47·437
CaO	0·430	0·225
FeO	0·776	—
	100·000	100·000

Correcting for lime and iron, by assigning each its share of CO_2, the Snarum magnesite gives as the true percentage of magnesia in pure magnesium carbonate the figure 47·624. To this, without serious mistake, we may assign the weight indicated by the probable error, ± 0·0037; the quantity previously deduced from the percentages of MgO given in the uncorrected analyses.

From the Frankenstein mineral, similarly corrected, the final mean percentage of MgO in $MgCO_3$ becomes 47·628. This, however, represents three series of analyses, whose combined probable errors may be properly assigned to it. The combination is as follows:—

± 0·0022
0·0069
0·0077

Result ± 0·0020, probable error of the general mean.

We may now combine the results obtained from both magnesites:—

Snarum mineral ..	Per cent MgO,	47·624	± 0·0037
Frankenstein mineral	,,	47·628	0·0020
General mean	,,	47·627	± 0·0018

The last investigation upon the atomic weight of magnesium which we have to consider is that of Dumas.* Pure magnesium chloride was placed in a boat of platinum, and ignited in a stream of dry hydrochloric acid gas. The excess of the latter having been expelled by a current of dry carbon dioxide, the platinum boat, still warm, was placed in a closed vessel and weighed therein. After weighing, the chloride was dissolved and titrated in the usual manner with a solution containing a known quantity of pure silver. The weighings which Dumas's reports give, as proportional to 100 parts of silver, the quantities of $MgCl_2$ stated in the third column:—

2·203 grms. $MgCl_2$ =	4·964 grms. Ag.	44·380
2·5215 ,,	5·678 ,,	44·408
2·363 ,,	5·325 ,,	44·376
3·994 ,,	9·012 ,,	44·319
2·578 ,,	5·834 ,,	44·189
2·872 ,,	6·502 ,,	44·171
2·080 ,,	4·710 ,,	44·161
2·214 ,,	5·002 ,,	44·262
2·086 ,,	4·722 ,,	44·176
1·688 ,,	3·823 ,,	44·154
1·342 ,,	3·031 ,,	44·276
	Mean	44·261 ± 0·020

There are now before us the following ratios, from which to deduce the sought-for atomic weight:—

(1.)	$MgSO_4$: $BaSO_4$ :: 100 : 193·700	± 0·0331
(2.)	MgO : $MgSO_4$ :: 100 : 296·806	0·0475
(3.)	Per cent of MgO in oxalate, 27·3665	0·0023
(4.)	Per cent of MgO in carbonate, 47·627	0·0018
(5.)	Ag : $MgCl_2$ :: 100 : 44·261	0·020

From these we find three values for the molecular weight of MgO:—

From (2)	MgO =	40·587	± 0·0126
From (3)	,,	40·603	0·0069
From (4)	,,	39·922	0·0030
General mean.. ..	,,	40·054	0·0027

* Ann. d. Chem. und Pharm., 110, 240.

* Ann. Chem. Pharm., 113, 33. 1860.

We have also three values for the atomic weight of magnesium:—

From molecular weight of MgO ..	Mg = 24·091	± 0·0044
From ratio (1), corrected	„ = 24·283	0·033
From ratio (5), Dumas	„ = 24·576	0·032
General mean	„ = 24·103	0·0043

Or, if O = 16, Mg becomes = 24·159.

In this general mean all the determinations are included, good or bad. Dumas's result is unquestionably wrong; the error, probably, being due to the presence of oxychloride in the $MgCl_2$ which was used. It is doubtful whether any precautions could have eliminated that error. If we take only Marchand and Scheerer's work on magnesium carbonate as having positive value, we shall get from their analyses the following result, viz.: Mg = 23·959, ∓ 0·0046. Or, if O = 16, this becomes 24·014. The atomic weight of magnesium, therefore, varies from the whole number 24, only within the ordinary limits of experimental error.

The following additional note has been communicated by the author:—The atomic weight of this metal has very recently been revised by Marignac. Ten syntheses of $MgSO_4$ from MgO gave in mean Mg = 24·38. Twelve determinations made by calcining $MgSO_4$ and weighing the residual oxide gave Mg = 24·37. In his calculations Marignac uses Stas's value for S, and puts O = 16. (*Arch. des Sci. Phys. et Nat.* (3), 10, 206).—F. W. C.

ON THE

USE OF MERCURY THERMOMETERS, WITH PARTICULAR REFERENCE TO THE DETERMINATION OF MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

(Continued from p. 301).

*Thermometers with a Limited Scale.**

Thermometers of this kind have been frequently used within the last few years to meet the difficulty of heating the entire mercury column, and it is generally recognised that it is inexpedient in ordinary experiments to attempt to make a correction for the portion of the scale which cannot be heated. Thermometers with a short scale have a reservoir blown in the glass about 1 c.m. above the bulb in order to contain the mercury corresponding to the number of degrees that it is intended to suppress. The total length of the useful part of the scale is about 15 c.m., but it is advisable to prolong the stem some 15 c.m. more for the convenience of fixing the thermometers in a boiling apparatus.

This mode of construction has some disadvantages which it is most important to remedy, since thermometers of this kind are the only ones which should be applied in accurate work at high temperature.

1. The rise of the zero-point is particularly hurtful because the mercury at zero eventually stands in the reservoir and the verification of the zero-point becomes impossible. These thermometers should always be subjected to the preliminary treatment which has been described in order to prevent the rise of the zero-point.

2. The determination of the fixed points which limit the scale of these thermometers (for example, the points 200° and 300°) has hitherto been made by methods far less accurate than those which are used for determining the points zero and 100°. If the constructor has determined these points by comparison with a standard thermometer in an oil-bath, errors of 5° are not uncommon, and much larger ones have been noticed. The only expedient which suffices to give results which can be compared with those obtained by observing the boiling-point of water and the melting-point of ice, consists in using a similar method for high temperatures. I have not succeeded in finding any melting-points constant enough for this use, but the boiling-points of several pure substances can be employed like that of water. Geissler introduced several years ago the use of naphthalene* for this purpose, and this step is a most important improvement; but he does not appear to have determined the boiling-point of naphthalene with an air thermometer, and the temperature which he gives is about 1° too low.

After having examined a great number of substances boiling between 150° and 360° I have only found two that unite all the qualifications which fit them for this use; they are naphthalene and benzophenone.†

It is not necessary that these bodies should be absolutely pure, provided the impurities do not affect the boiling-point, and some criterion can be established to mark the requisite degree of purification. It was found that the boiling-point of commercial naphthalene did not vary more than 0·10° when it had been purified by any method (chemical or physical fractional distillation or crystallisation) until the melting-point was brought to 79·9°—79·6°.

The same is true of benzophenone prepared by means of oxychloride of carbon, when it is purified until its melting-point is at 48·0° to 47·7°. It will be seen that considerable limits can be tolerated in the melting-points without an equal change in the temperature of the boiling-point: in other words, the common impurities cause the melting-point to vary, while they have nearly the same boiling-point. This quality was regarded as indispensable for the use in view, and it was found necessary to reject diphenyl-methane and other substances because they do not fulfil this condition. Bodies like essence of turpentine, which are capable of isomeric changes on heating, alcohols which absorb or give off water, ethers which are decomposed by moisture, as well as most acids, chlorides, and similar bodies, are unfitted for the purpose. A primary

* Thermometers of this kind made at Paris give the zero-point and temperatures commencing with about 10°, 20°, 100°, 150°, and so forth. In Germany, thermometers are much used which have the bulb only partially filled and whose scale runs from 98° to 360°.

* Dr. Geissler was kind enough to send me some of the naphthalene which he was in the habit of using, and I found it quite pure. The lower boiling-point which he has given is not necessarily in error, if the determination was made with a soda glass thermometer, because such an instrument might really give at 218° about 0·5° lower than the air thermometer, and an imperfection in the boiling apparatus used would easily account for the remainder. Geissler's thermometers do actually mark about 1° too low at this temperature.

† A mode of preparation of benzophenone, which was given by Friedel, Crafts, and Ador (*Comptes Rendus*, lxxxv., 672), renders the preparation of this substance possible on a large scale and with the necessity purity. The details of the process will be given elsewhere, but it may be well to indicate one or two points which show that it can be applied without difficulty in a manufactory of chemical products. Oxychloride of carbon is made to act upon benzene in the presence of chloride of aluminium. No difficulty is found in regulating the supply of carbonic oxide when the gas is passed first into a large floating gas-holder containing 50 litres; very simple means suffice to mix in equal volumes chlorine and carbonic oxide, and if the mixture is well made there is scarcely a limit to the rapidity with which it may be passed through a large apparatus in bright sunlight. Three glass balloons of 10 m.m. capacity each were used, and the combination takes place chiefly in the first with a considerable evolution of heat. In diffused light the current of the two glasses must be relatively slow. When carbonic oxide has been used in slight excess the product frequently contains no free chlorine, and in any case an excess of chlorine may be conveniently removed by passing the product into a fourth balloon containing a little benzene exposed to the sunlight. Under the circumstances this absorbent for chlorine is more convenient than zinc or antimony; the rate of formation of oxychloride of carbon can be estimated by condensing it in benzene cooled first with ice and then with a freezing mixture. 100 grms. an hour can be obtained with great regularity, and the chloride of aluminium can be subsequently added to this mixture, or the oxy-chloride of carbon can be passed directly into benzene to which 25 per cent chloride of aluminium has been added. When the benzene used has been purified by distillation or by fractional crystallisation until its melting-point is above 4·5°, the crude benzophenone contained in the reaction is almost pure. It varies only about half degree in its boiling-point, and the subsequent complete urification is easy.

requisite for this purpose is stability on heating. That of naphthalene is well known, and the inalterability of benzophenone, when boiled for ten days even under pressure, was tested with perfectly satisfactory results. The vapour-density of benzophenone is normal even at a red heat.

The boiling-points of pure naphthalene and benzophenone were determined with great care by means of the hydrogen thermometer under pressures varying from 85 m.m. to 1800 m.m. and a formula found representing their vapour tension. These results, which will be described elsewhere, give the means for heating at will to any fixed temperature between 100° and 360°.

It will be sufficient for our present purpose to give in the following table the boiling-points of these two substances under the ordinary atmospheric pressures.

Vapour Tensions.

Naphthalene. Temperature.	Naphthalene. Millimetres.	Benzophenone. Temperature.	Benzophenone. Millimetres.
215·7	720·39	303·7	723·95
215·8	722·05	303·8	724·77
215·9	723·69	303·9	726·29
216·0	725·34	304·0	727·80
216·1	727·00	304·1	729·33
216·2	728·65	304·2	730·86
216·3	730·31	304·3	732·38
216·4	731·98	304·4	733·92
216·5	733·65	304·5	735·45
216·6	735·32	304·6	736·98
216·7	736·99	394·7	738·52
216·8	738·67	304·8	740·06
216·9	740·35	304·9	741·60
217·0	742·03	305·0	743·14
217·1	743·72	305·1	744·69
217·2	745·41	305·2	746·24
217·3	747·10	305·3	747·79
217·4	748·80	305·4	749·36
217·5	750·50	305·5	750·91
217·6	752·20	305·6	752·47
217·8	753·90	305·7	754·03
217·9	755·31	305·8	755·60
218·0	759·02	305·9	757·17
218·1	760·74	306·0	758·74
218·2	762·46	306·1	760·32
218·3	764·18	306·2	761·90
218·4	765·91	306·3	763·48
218·5	767·63	306·4	765·06

Apparatus for Vapour Tensions.

Under the atmospheric pressure the above substances can be used for fixing the scales of thermometers or for correcting them in any kind of glass apparatus, and when a thermometer is to be used for ordinary distillations the corrections can be most conveniently made by boiling in the same vessel some substance of known boiling-point falling nearly at the same temperature; and if the scale cannot be entirely heated, the same number of degrees may be left outside in the two cases to be compared. With proper precautions a series of corrections can be thus established with an error of less than 0·5°; but the temperatures that are read off on the thermometers under these circumstances are not usually the true ones, and the corrections must be based upon the known boiling-points of the standard substances, which have been determined with special care. Some directions regarding the use of corrected thermometers with a limited scale are given further on under the heading Distillation, but a greater accuracy has been aimed at with the standard apparatus destined for the manufacture or the exact correction of thermometers. The chief difficulty is to avoid superheating the lower strata of vapour, when a column high enough to envelop the scale of the thermometer is heated. If, for instance, benzophenone is boiled in a large glass vessel, with a neck at least 5 c.m. wide, it requires a very powerful heat to maintain a column of vapour 30 to 40 c.m. high, and an ordinary long thermometer is found to vary 2 to 3 tenths of a degree according as it is raised or lowered a few centimetres in the vapour.

Considerably better results are obtained by surrounding the neck of the flask with a non-conducting jacket of plaster or mineral wool, and following in the direction thus indicated, various forms of metallic apparatus were constructed, in which a sensitive thermometer with a short scale showed the same temperature to within less than one-tenth degree when placed at any height above the boiling liquid.

Figures 1 and 2 represent a copper apparatus specially adapted to the graduation of thermometers. The metal is 2 m.m. thick and will bear a pressure of two atmospheres. All the parts are brazed. The space between the true apparatus B and an outer cylinder A made of stove-pipe is 3½ c.m. It is filled with mineral wool to prevent radiation. B is 8 c.m. largest diameter and 47½ long. The section Fig. 1 shows its elliptical form, and the smaller diameter is 5½ c.m. C represents an inner tube of thin copper intended to protect the vapours from condensation. It is pierced with holes as shown by the dotted portions near the bottom and the top. The vapours rise principally between this tube and D, and the condensed liquid runs down the sides of B. D represents a flattened tube, 3 c.m. by ½ c.m. in section, and 43 c.m. long. It contains five or six thermometers, which can be conveniently observed together by means of a telescope. When the thermometers are nearly of the same size they may all be held at the requisite height by the slight pressure of a single spring clamp, or they may be grasped by a series of watch-spring clamps, or simply suspended from threads. An easy adjustment of the height is important. The vapours are condensed in the tube E, and the condenser is of a peculiar form to prevent the stoppage of the tube by the solidification of crystalline substances. Water is allowed to flow constantly into *g*, and out drop by drop at *g'*, and the water consequently remains always at the level of *g'* in the condenser. The water is soon heated to boiling, the steam escapes at *h*, and the vapours of naphthalene and other substances are condensed at 100° instead of at the ordinary temperature, and flow back as liquids. In an ordinary operation it is not even necessary to renew the water, and it is only when the heating is long-continued that a flow of water becomes necessary. For substances which like benzoic acid melt higher than 100°, the water may be replaced by amylic alcohol or by some other convenient liquid, and a lead tube (not shown in the figure) soldered upon *h* can be so arranged as to return the amylic vapours in the form of liquid to the condenser at *g*.

The apparatus of Figs. 1 and 2 is long enough to heat any ordinary thermometer, but when a great sub-division of the scale makes it of unusual length, the protruding portion of the stem is heated to the same temperature by the cylinder (Fig. 3), which is put upon the top of the first, and contains the same standard substance. The non-conducting jacket is so arranged as to allow the flame to play around B, and this part of the cylinder projects enough to allow a lamp to be placed under it. Any number of such cylinders may be superposed, so that there is no limit to the length of a thermometer which may be heated to a fixed temperature without danger of superheating the vapours.

Several questions regarding the accuracy of this method of fixing temperatures required to be studied experimentally.

The temperature was found to be exactly the same whether the interior tube D was used as an air-bath or was filled with high-boiling paraffin, and the use of oil or paraffin was rejected because it has many inconveniences. The tube D can be made cylindrical and of much larger dimensions to fit it for air thermometer work, without making any difference in the temperature, when the mouth is well stopped with asbestos.

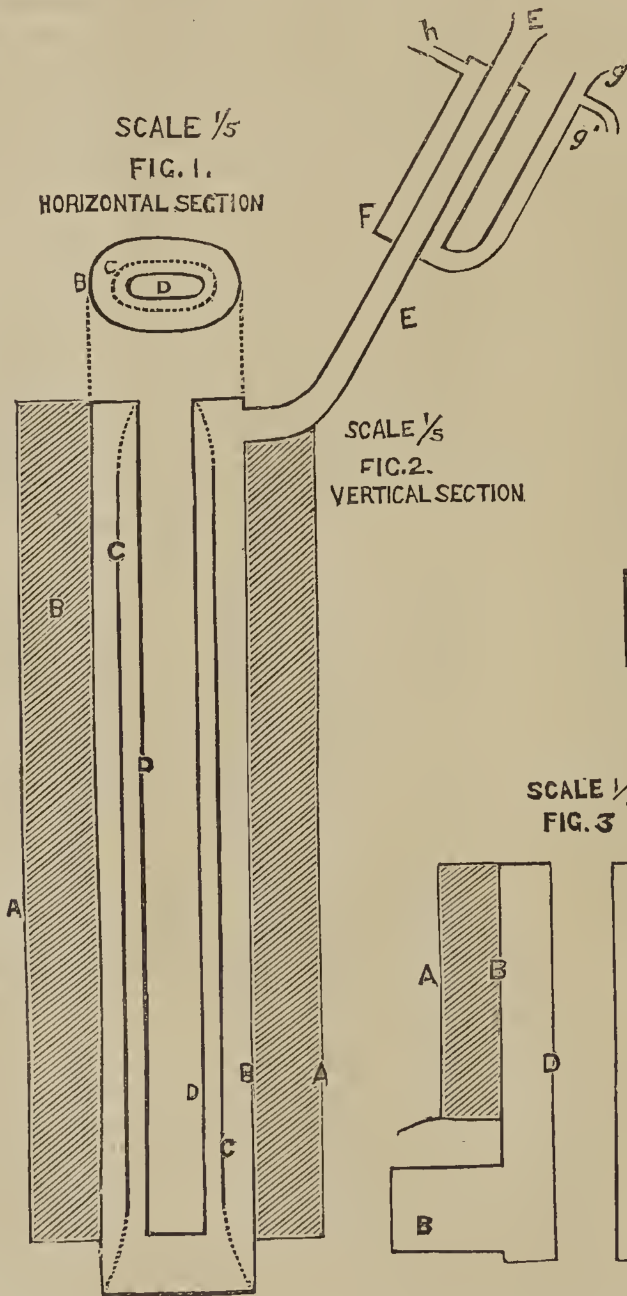
It was thought possible that the condensed liquid from

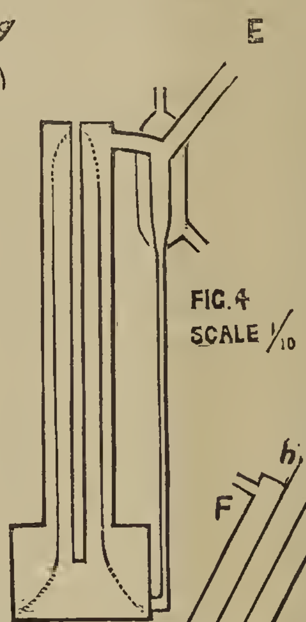
E flowing back along the sides of D might lower the temperature, and comparative experiments were made with the apparatus described and with that represented on a smaller scale (Fig. 4), in which the vapours are so condensed as to be returned by the small tube E to the bottom of the apparatus. The results were identical in each case.

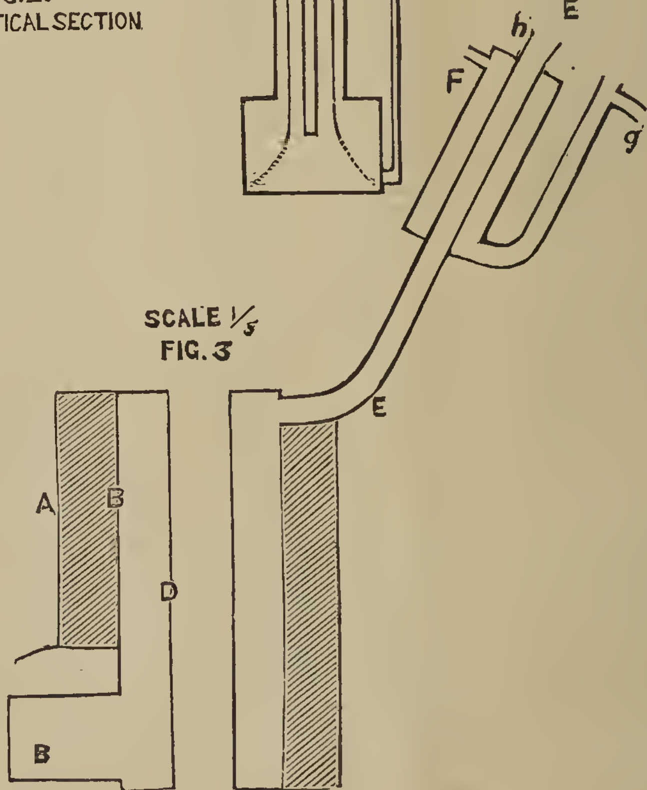
Other experiments were made by enlarging the bottom of the cylinder and by varying the quantity of the liquid, and it was found that such variations made no difference in the temperature, provided radiation of heat was well

This requires a certain adjustment, which can be made after they have been heated about ten minutes; and since this operation may bring cool parts of the stem in contact with the tube D, and change the temperature of the air-bath, eight to ten minutes must usually elapse after the final adjustment before the temperature becomes constant and before the final reading should take place. For this cause there is even a certain advantage in replacing the single tube D by a number of smaller ones, each containing a single thermometer.

The liquid must be made to boil constantly, so that the







guarded against. The simplest form, Figs. 1 and 2, was therefore chosen, and it is believed that it is well adapted to obtaining the true boiling-point of a high-boiling substance, as Rudberg's (Regnault's) apparatus is to measuring the boiling-point of water.

A smaller apparatus, in which the interior tube D is cylindrical and only 5 m.m. in diameter, is used for examining a single thermometer, and it can be used more quickly since it requires only six to eight minutes for the temperature to become stationary. With the larger apparatus a longer time is required, and the error which is most likely to occur on working with it arises from not waiting patiently until the mercury column has become stationary.

The thermometers are plunged in the tube D so that at the moment of reading only about 1° appears above the top.

condenser is heated with about equal rapidity in all determinations, a point which there is no difficulty in appreciating.

All these forms of apparatus can easily be connected at E with a reservoir of about 20 litres capacity, filled with air at any pressure, and no difficulty was found in boiling naphthalene and benzophenone under pressures varying from 100 to 1500 m.m., so that any temperature within the ordinary thermometric scale can be determined, and the apparatus can thus be used for correcting or for graduating the whole scale.

The examination of different points in the scale of a thermometer by means of such an apparatus may replace advantageously all the corrections arising from errors of graduation, calibration, and the departure from the air thermometer scale. The operation is more accurate and

infinitely less tedious than the usual ones for temperatures higher than 100°.

(To be continued.)

CORRESPONDENCE.

VOLUMETRIC ESTIMATION OF MANGANESE.

To the Editor of the Chemical News.

Sir,—I beg to call Mr. Stone's attention to a method of estimating the manganese in spiegels, more rapid than, and about as accurate as, those he refers to in the Chemical News, vol. xlviii., p. 273.

It has been in use here for some time. The results obtained by it have been very frequently compared with those obtained by the usual gravimetric method, and we have found a remarkably close agreement: seldom 0·4 per cent difference, and more frequently 0·2 per cent or less.

It is a modification of the well-known indirect method of estimating the iron present, adding a certain constant number, 5 or 6 usually, and calling the rest manganese. I have found by estimating the silicon as well as the iron, and adding 5 per cent, that the remainder expresses the per cent of manganese present within the narrow limits just mentioned, and this seems to hold good for spiegels containing 8 to 30 per cent manganese. Beyond this I have as yet had no experience, and further modifications may be then required.

The method of operating is as follows:—Dissolve about 0·5 grm. of finely powdered spiegel in dilute H_2SO_4. When completely dissolved, dilute, and titrate with bichromate as usual. The silicon is quickly separated by dissolving 2 grms. of spiegel in slightly dilute HCl, using a wide beaker on a hot plate and evaporating to dryness; re-dissolve in HCl, filtering, washing, and igniting as usual.

There is nothing new in the method of analysis, but the estimation of the silicon in addition to the iron most certainly adds very much to the correctness of the results, and I have not heard of its being done as a regular thing before. Of course it is most advisable with a fresh series of spiegels from a new source to check these results by the gravimetric method in order to see whether the 5 per cent for carbon, &c., is sufficient allowance or too much; but half a dozen determinations ought to settle that point.

The method I have now proposed is, of course, not intended to supplant the gravimetric method, but to enable works' chemists to ascertain with rapidity and fair accuracy what the per cent of manganese actually is. I subjoin a few, from scores of similar results obtained in this laboratory, for comparison, one operator estimating the m.m., by Fe+Si+5 per cent, and another doing the same sample gravimetrically:—

Fe+Si+5 per cent. Manganese per cent.	Gravimetric. Manganese per cent.
27·79	28·10
24·48	24·63
22·88	23·04
20·61	20·30
18·80	18·70
13·18	13·24

—I am, &c.,

A. H. Holdich.

Wigan Coal and Iron Co.

VAPOUR-TENSIONS OF MERCURY.

To the Editor of the Chemical News.

Sir,—I have just read Prof. McLeod's paper on the pressure of mercury vapour (Chemical News, vol. xlviii., p. 251), and the question arises in my mind whether so heavy a vapour would saturate the whole interior of the flask, from so small a surface, in a few days or a month. The method might well be applied to studies in gaseous diffusion; for example, by connecting a series of Wolff bottles, and testing the contents of each after a certain interval.—I am, &c.,

Robt. B. Warder.

Lafayette, Ind., Dec. 17, 1883.

THE LATE MR. RICHARD TALLING.

To the Editor of the Chemical News.

Sir,—The recent death of Mr. Richard Talling deserves, I think, a passing notice in the pages of your journal. Although not a chemist, Mr. Talling possessed a wonderful knowledge of minerals, and it is not too much to say that the mineralogy of his own county, Cornwall, is largely indebted to him for the development of many new and most interesting specimens. In finding a mineral which he had not observed before, Mr. Talling immediately submitted it to those competent to undertake its analysis, and the *Journal of the Chemical Society* bears ample testimony to his zeal and perseverance, in the papers of Professors Maskelyne, Church, and others. Some fifteen months ago, Mr. Talling, at my request, sent me a list, of which the following is a copy, comprising the various minerals which he actually had discovered, as *new* to science or previously unknown to British mineralogy, which will give some idea of the extent of his labours. The list is entirely his own, and I am not responsible for any errors that may exist therein.

Minerals New to Science.

Name.	Determined by.
Andrewsite	Prof. Maskelyne
Bayldonite	Prof. Church
Botallackite	,,
Churchite (very rare)	,,
Chenevixite	Prof. Pisani
Develline	,,
Langite	Prof. Maskelyne
Ludlamite	Mr. Fred. Field
Tavistockite	Prof. Church
Tallingite	,,
Warringtonite	Prof. Maskelyne
Liskeardite	(?)

Minerals New to British Mineralogy.

Name.	Determined by.
Bleinierite	Dr. Percy
Agalmatolite	Dr. Greg
Atacamite	Prof. Church
Marmatite	,,
Ehlite	,,
Eulytine (very scarce indeed)	(?)
Hisingerite	Prof. Church
Frankolite (new variety)	Prof. Maskelyne
Chalcosiderite	,,
Cronstedtite (new variety)	Mr. Fred. Field
Dufrenite (?)	* ,,

It must be allowed, I think, that some of the most splendid specimens in the magnificent collection of the British Museum have been obtained from Mr. Talling, and the principal museums throughout Europe and America are enriched and beautified by his contributions.

It would be well for mineralogy if there were more men amongst us with the energy and sagacity of the late Mr. Talling. How many new and beautiful specimens might have been saved that have been heedlessly cast into the smelting furnace!—I am, &c.,

Frederick Field.

* This very interesting mineral, which I am persuaded is Dufrenite was under examination when illness compelled me to leave England. I did not care to publish my results until further experiments had corroborated my first determinations. I have a specimen in my collection.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 22, November 26, 1883.

Hydration of Crotonic Aldehyd.—Ad. Wurtz.—The author's experiments go to prove that aldol and its condensation products are formed by the hydration of crotonic aldehyd under the influence of water and of hydrochloric acid. He has not succeeded in isolating crotonic aldehyd.

A Magnetic Induction-Compass.—M. Mascart.—The author's apparatus comprises an azimuth circle upon which moves an arrangement carrying a ring movable on an horizontal axle; the angle which this ring makes with the horizon is measured by a vertical circle; the frame, only 0·12 metre in diameter, is supported by the ring, and can turn upon an axle perpendicular to that of the ring. The dimensions of the instrument are not greater than those of an inclination-compass.

Electric Synchronism of Two Relative Movements, and its Application to the Construction of a New Electric Compass.—Marcel Deprez.—This memoir does not admit of useful abstraction.

The Study of Telluric Currents.—E. E. Blavier.—It is concluded, contrary to the general opinion, that underground lines are not more influenced by terrestrial currents than are aërial lines. If such currents disturb transmission on the subterranean lines rather more, this is because their copper conductors offer less resistance. The telluric currents have evidently an intimate connection with the variations of the earth's magnetism. Whether they are the cause or the effect of these variations can only be decided by a comparison of the electric and the magnetic curves. An attentive study of the former will decide if the movements of the sun and moon have an inductive influence, as certain physicists think.

Force of Induction Produced at a Distance by any System whatever of Small Plane Electric Currents of Varying Intensity: Equivalent Spherical Selenoid.—M. Quet.—A mathematical paper, not capable of useful abridgment.

Measurement of the Difference of Potential of the Electric Strata which cover two Liquids in Contact.—E. Bichat and R. Blondlot.—This memoir requires the four accompanying diagrams.

Micro-thermometer for the Measurement of very small Variations of Temperature.—F. Larroque.—The author has constructed thermometers, by means of which he can estimate variations of temperature to $\frac{1}{1000}$ degree.

Studies on the Chemical Action of Light: Decomposition of Oxalic Acid by Ferric Chloride.—G. Lemoine.—This paper requires the accompanying diagrams.

Dissociation of Anhydrous Ammonium Carbonate in presence of an Excess of its Elements.—M. Isambert.—Experiment verifies the law established theoretically, admitting decomposition at the moment of evaporation, and these measurements confirm the fact of this decomposition, which the author has previously established by the compressibility of this vapour.

Fusibility of Salts, Nitrates.—E. Maumené.—Barium and strontium nitrates cannot be melted; but if they are placed in small crystals upon a mass of potassium or sodium nitrate they can be melted without any loss of oxygen or of nitrous acid. Barium nitrate with potassium nitrate in equal equivalents melts at 370°. A mixture of alkaline nitrates with ammonium nitrate melts at 122°, and may serve instead of an oil-bath.

Hydro-nicotine and Oxy-tri-nicotine.—A. Etard.—Hydro-nicotine, $C_{10}H_{16}N_2$, is an oily substance, of sp. gr. 0·993 at 17°, and boils at 263°. It is soluble in water, alcohol, and ether in all proportions. Oxy-tri-nicotine has the composition $C_{30}H_{27}N_6O_2$.

No. 23, December 3, 1883.

Absorption-Spectrum of the Blood in the Violet and Ultra-violet Part.—M. J. L. Soret.—The author has previously mentioned the absorption-band which diluted blood gives in the violet portion of the spectrum. With blood diluted to $\frac{1}{1000}$, and of the thickness of 10 m.m., this band occupies about the half of the interval comprised between G and H, its centre falling upon *h*; the ultra-violet is transmitted. With the blood at $\frac{1}{600}$ it fills the entire space between G and H, the region beyond H being darkened. With blood at $\frac{1}{400}$ it spreads beyond G and especially beyond H; all the ultra violet is much darkened. If the blood has been treated with carbon monoxide this band is slightly driven back from the more refrangible side, and the ultra-violet is less darkened than with oxygenated blood of equal dilution.

Secular Variation of the Direction of the Terrestrial Magnetic Force at Paris.—M. L. Descroix.—The author gives his results in the form of tables.

Measurement of the Difference of Potential of the Electric Strata which cover two Liquids at Contact.—MM. E. Bichat and R. Blondlot.—An illustrated paper, not adapted for useful abstraction.

Researches on the Duration of the Solidification of Superfused Sulphur.—D. Gernez.—The variations which the author has observed in the solidification of prismatic sulphur depend evidently on the changes experienced by the specific heat of the liquid sulphur and the solidification heat of the prisms. Liquid sulphur is capable of undergoing, at a constant temperature, a modification which depends on the duration of action of the source of heat.

Formation-Heat of Certain Lead Oxychlorides and Oxybromides.—G. André.—The heat developed increases by about + 1 cal. for the addition of each equivalent of lead oxide.

Artificial Production of Spessartine or Manganiferous Garnet.—A. Gorgen.—The author treats a mixture of manganese chloride and of clay at a cherry-red heat with a current of hydrogen saturated with watery vapour.

Researches on Saccharogeny in the Beet.—Aimé Girard.—A lengthy account of the origin and accumulation of betose in the tissues of the beet-plant.

On Bi-primary Bichlorised Ethyl Acetate.—Louis Henry.—This compound is a colourless liquid, of a slightly pungent odour and a burning taste. Its spec. gr. at 10·6° is 1·3217, and it boils at 197°—198°. It is insoluble in water.

Conditions suitable for accelerating the Oxidation of Drying Oils.—Ach. Livache.—The author finds that manganese is the most effective desiccating agent.

Bulletin de la Société Chimique de Paris. No. 8, November 5, 1883.

Explosive Wave.—MM. Berthelot and Vieille.—The researches of the authors reveal the existence of a new kind of undulatory movement of a mixed order, produced in virtue of a certain concordance of physical and chemical impulsions within a substance which is undergoing transformation. The characteristic of this order of phenomena is the production of an explosive wave, *i.e.*, of a regular surface in which the transformation is developed. This surface, when once produced, is propagated from layer to layer throughout the entire mass, in consequence of the transmission of the successive shocks of the gaseous

molecules, which are brought to a more intense vibratory state by the heat liberated in their combination. Such effects are comparable to those of a sound wave, but with this capital difference, that the latter is transmitted with a very inconsiderable *vis viva*, a very small excess of pressure, and a speed determined solely by the physical constitution of the vibrating medium.

Reactions between Sulphur, Carbon, their Oxides, and their Salts.—M. Berthelot.—If sulphurous acid is submitted to electrolysis in a sealed tube with platinum electrodes, the decomposition is arrested after a certain point. No free oxygen is formed, but a part of the sulphur combines with the platinum, the surplus forming with the sulphuric anhydride a viscous compound, which then absorbs a portion of the sulphurous gas. The decomposition of carbon monoxide under the influence of the spark, or of a red heat, is limited in extent. It begins long before white redness. The author further studies the mutual behaviour of sulphur and carbon in their various combinations.

Arrangement for the Use of the Penumbra Saccharimeter.—E. Allary.—Instead of being lighted by a lamp the polariser is enclosed in a cylinder of pasteboard, blackened within and pierced with a circular aperture, covered with a transparent yellow paper as nearly as possible approaching the shade of the spectral yellow. The observer then covers the entire apparatus and his own head with a black veil, and proceeds to the study of the solutions in question.

MEETINGS FOR THE WEEK

MONDAY, Jan. 7th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 8th.—Royal Institution, 3. "Alchemy," by Prof. Dewar.
—— Royal Medical and Chirurgical, 8.30.
—— Institute of Civil Engineers, 8.
—— Photographic, 8.
WEDNESDAY, 9th.—Microscopical, 8.
—— Geological, 8.
THURSDAY, 10th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
FRIDAY, 11th.—Astronomical, 8.
—— Quekett Microscopical, 8.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1259.

ON THE TEMPERATURE OBTAINED BY OXYGEN IN EBULLITION, AND ON THE SOLIDIFICATION OF NITROGEN.

By M. S. WROBLEWSKI.

OF all the gases formerly considered as permanent, hydrogen is the only one which has failed to give, at a temperature of $-136°$ C., any sign of liquefaction. Not even is there any cloud produced in the tube containing it if the gas at this temperature, compressed to 150 atmospheres, is suddenly released. To liquefy hydrogen we must evidently have recourse to a lower temperature than the lowest obtained by liquid ethylene allowed to boil in a vacuum. Among the gases which are more difficultly liquefiable than ethylene, and therefore suitable for the production of a much more intense cold, oxygen has appeared to me to be most easily available.

The conditions for the liquefaction of oxygen being well understood from the researches which I have had the honour to bring before the Academy, it follows that this gas can now be liquefied in considerable quantities with great ease. A thousand devices and kinds of apparatus may be imagined by which this liquefaction can be effected. Indeed, the industrial production of liquid oxygen is, I may almost say, only a question of the material means at the disposal of the experimentalist. Thus, I have employed, since the month of October last, liquid oxygen as a refrigerating agent, and I ask permission to lay before the Academy the results of my experiments.

Liquefied in large quantity, and suddenly allowed to evaporate by release of the pressure, oxygen does not solidify like carbonic acid, but it leaves a crystalline residue on the bottom of the apparatus in which it was kept in the liquid state and on the object to be cooled plunged in the oxygen. I am not able to say if this residue consists of crystals of oxygen only or if it is due to possible impurities, since the oxygen I used was prepared from a mixture of potassium chlorate and manganese peroxide. This residue disappears when the temperature begins to rise. If the body to be cooled is in a glass tube, the thin layer of this opaque residue is often very annoying for the observer.

Another circumstance which renders it very difficult to employ liquid oxygen as a refrigerating agent is the necessity of using it in closed vessels having great strength. I have not yet been able to obtain oxygen in the form of a static liquid at the normal atmospheric pressure. It has therefore been necessary to immerse the substances to be cooled in the apparatus which I fill with liquid oxygen, and I can only make use of the cold produced by the oxygen when boiling on the sudden release of the pressure. As these apparatus are partly constructed of glass great inconvenience is caused by the constant danger of serious explosions. After several accidents which have occurred during these experiments, my assistants and myself now always work with masks before our faces.

But the greatest difficulty in these experiments is the very short duration of the ebullition of liquid oxygen, and consequently the too short time of the refrigeration.

I have attempted to measure the temperature of oxygen when in a state of ebullition. For this purpose I have employed a thermo-electric method of measuring which, besides its great sensitiveness, admits of the registration of all the sudden changes of temperature of the medium. The indications of the apparatus have been compared with those of a hydrogen thermometer between $+100°$ C. and $-130°$ C. The nature of the function connecting these two indications permits an extrapolation being made.

Reserving the description of my method to a subsequent communication I may here give *one hundred and eighty-six degrees below zero* ($-186°$ C.) as the first approximation to the temperature produced by the sudden release from pressure of liquefied oxygen.

I have submitted nitrogen successfully to the action of this cold. This gas compressed, cooled in boiling oxygen, and then allowed to expand a little, solidifies and falls like snow in crystals of remarkable size.—*Comptes Rendus*, Dec. 31, 1883.

ON THE FORMATION OF SULPHURIC ACID IN THE LEAD CHAMBERS.*

By Professor G. LUNGE.

1. IN the ordinary course of working no hyponitric acid exists in the lead chambers. This acid takes no part in the formation of sulphuric acid. It arises merely as a secondary product and under quite peculiar circumstances.

2. In presence of a large excess of nitrous gases, the formation of N_2O_4 takes place in the last chamber, and in this there is very little sulphuric acid produced. It seems very probable that the absence or the reflux of sulphurous acid are of great importance for the production of N_2O_4.

3. The quantity of oxygen contained in the gas of the chambers has little influence on the formation of N_2O_4.

4. If the gaseous current in the chambers is yellow, the loss in N_2O_3 and N_2O_4 in the Gay-Lussac tower is of a certain importance, and under ordinary circumstances may rise to 60 per cent of the total loss.

5. If the gaseous current is colourless the loss in nitrate in the Gay-Lussac tower is equal to 0·5 per cent of nitre, or to 20 per cent of the entire loss. The gases which escape contain mere traces of N_2O_3 and N_2O_4, but, instead, NO and SO_2.

6. We never find N_2O_4 in the tower acid, even when the gases of the chambers and the escaping gases contain it.

7. During the transformation of SO_2 into H_2SO_4 there occurs an anomaly which is not without interest. As far as to the centre of the first chamber 75 per cent of the total quantity of sulphurous anhydride are transformed into sulphuric acid; from there to the end of the chamber only 4 per cent more of SO_2 are converted. The total quantity of SO_2 is further lessened by 10 per cent after the gases have traversed the connecting pipe between the first and the second chamber. The employment of a system of several chambers is very favourable to the good working of the plant, for in passing from one chamber to another the gases undergo a slight compression in the pipes, and are mixed in an intimate manner.

8. In the centre of the first chamber the mixture of gases is almost complete. The composition of the gaseous mixture is the same at different heights. At the centre there is from 0·1 to 0·2 per cent more SO_2 than along the sides.

9. It is improbable that the gases which penetrate into the chambers rise at first, and afterwards slowly redescend. They become quickly mixed already in the anterior portion of the first chamber.

10. The progress of the temperature in an entire system of chambers is very regular. In the first fourth part of the first chamber, where the chemical reactions are very intense, the temperature of the gases rises about 5° to 6°,

* A paper read before the Helvetic Society, based upon results obtained by M. Naef, of the Uetikon Works, under the author's direction.

and then falls slowly. Towards the end of the series of chambers the fall of temperature is a little stronger.

11. On increasing the cubic measurement of the chambers from 1·5 to 1·8 metres per 3 kilos. of sulphur burnt in the two first chambers, there is observed a decrease of temperature of from 9° to 10°, and in the third of 5° to 6°.

12. The reduction of temperature by the sides of the chambers is scarcely perceptible in the interior beyond the distance of 25 centimetres from the side, the ambient temperature being 19°. At 5 to 10 centimetres from the side the reduction of temperature is 2°, and at 10 to 25 centimetres only 1°. From the distance of 25 centimetres from the wall to the middle of the chamber the difference of temperature is 5°, and from the side to the centre 8°.

13. In the middle of the first chamber the temperature is lower by 5° at the bottom than at the top.

14. The use of the pulverised water instead of steam has no great influence upon the temperature of the chambers.—*Moniteur Scientifique Quesneville.*

ON THE VOLUMETRIC DETERMINATION OF MERCURY.

By GUSTAV KROUPA.

If recently precipitated mercurous chloride is covered with sulphuretted hydrogen water, the mercurous chloride is at once transformed into sulphide and hydrochloric acid. If the excess of hydrogen sulphide is removed in a suitable manner, and the quantity of chlorine in the solution determined, the proportion of mercury may be readily calculated. The author proceeds in the analysis as follows.—If the mercury is present in the mercurous state it is precipitated at once with sodium chloride. If it exists in the mercuric state and no hydrochloric acid is present, a sufficiency of sodium chloride is added, and then a solution of ferrous sulphate and an excess of potassa. The mixture is allowed to stand for a few minutes in the cold, and is diligently stirred with a glass rod. The precipitate of mercurous oxide and ferroso-ferric oxide is strongly acidified with dilute sulphuric acid and stirred till the black precipitate has become a pure white, the formation of mercurous chloride being complete. This is filtered off, washed well, placed along with the filter in a beaker, covered with sulphuretted hydrogen water, and allowed to stand for a few minutes. The hydrochloric acid formed is neutralised by the addition of an excess of elutriated barium carbonate, whilst the excess of hydrogen sulphide is removed by a solution of zinc acetate, which at the last is added in drops until no more odour of hydrogen sulphide is perceptible. The precipitate is filtered again, and, after washing, the filtrate is mixed with an excess of potassium chromate and titrated with silver solution in such a manner that at first a small excess of silver is run in, which is removed by means of a measured quantity of an equivalent solution of sodium chloride and the operation finally completed with a centinormal silver solution.—*Chemiker Zeitung* and *Oesterr. Zeitschrift Berg. und Hütten.*

DETERMINATION OF IODINE IN A MIXTURE OF IODIDES, BROMIDES, AND CHLORIDES.

By A. CAVAZZI.

From a mixture of chlorides and iodides the iodine can be isolated by a boiling solution of neutral ferric chloride, but if bromides are present bromine also is liberated. In order to remove the iodine alone from a mixture of the three kinds of haloid compounds, the author uses ferric sulphate instead of the corresponding chloride. It must be previously heated almost to redness in order to make it perfectly free from acid. As the calcined salt dissolves with difficulty in water a little ferrous sulphate is added, which increases the solubility and renders the solution permanent. Two grms. ferric sulphate, in presence of 0·1 to 0·2 grm. ferrous sulphate, dissolve readily in 25 c.c. of boiling water. If a mixture of chloride, bromide, and iodide is boiled with this solution the iodine alone is separated out. The author absorbs the iodine in potassa, reduces the iodate to iodide by means of hydrogen, which is evolved in the alkaline solution by aluminium, and precipitates the iodine with silver nitrate.—*Chemiker Zeitung.*

PARATOLUIDINE SULPHATE AS A REAGENT FOR NITRIC ACID.

By A. LONGI.

If a liquid holding in solution nitrates is mixed with a few drops of paratoluidine sulphate, and superstratified with sulphuric acid, there appears at the boundary of the two liquids an intense red colouration, which passes into a dark yellow only after a considerable time. Crude aniline may be used instead of pure paratoluidine. The red colouration can be recognised in fluids containing $\frac{1}{32000}$ nitric acid. The reaction is less sensitive than that obtained with brucine and diphenylamine, but it has the advantage of producing a different colour (blue) with chloric, bromic, iodic, chromic, and permanganic acid. It can also be used for distinguishing nitric from nitrous acid, since it produces with the latter a yellow colouration which gradually passes into red.—*Gazzetta Chemica.*

DETECTION OF FREE SULPHURIC ACID IN PRESENCE OF ALUMINIUM SULPHATE.

By O. MILLER.

The author has endeavoured to utilise the azo-dyes for the detection of free sulphuric acid in cake-alums,—a matter of great importance for paper-makers. Free acid destroys the ultramarine, but precipitates fine particles of resin from the size, which appear then in the paper as transparent spots. Lunge has applied the reaction of tropeoline OO for this purpose, but the author has not met with any precise statement concerning the result. He has compared the behaviour of tropeoline and of methyl- and ethyl-orange with the reactions of logwood as formerly proposed.

His experiments show that among all known reactions those of methyl-orange afford, not merely the most certain means for the detection of free sulphuric acid in cake-alum, but also for its quantitative determination.

With this indicator he has been able to detect 0·01 grm. free sulphuric acid per litre along with 0·645 grm. aluminium sulphate, and even to show the dissociation of this salt on boiling its watery solution.

For the quantitative determination of the free acid he extracts the sample in the cold with alcohol, evaporates the alcoholic solution at a very gentle heat on the water-bath almost to dryness, re-dissolves in cold water, and titrates with decinormal alkali.

Tropeoline is not affected by neutral aluminium acetate, but it is not sufficiently sensitive to free acid. Ethyl-orange is very sensitive to free acid, but takes a rose-colour with neutral sulphate of alumina, so that the further change produced by free acid cannot be distinctly recognised.

Methyl-orange is exceedingly sensitive to free acid, and is coloured by pure, neutral aluminium sulphate, not rose, but orange, so that the change to a rose in presence of free acid is very distinct.

The other reactions which have been proposed are unsuitable. Gisecke's test with decoction of logwood has the defect that it appears only after the lapse of two or three minutes. Stein's test with ultramarine paper is not sufficiently sensitive.

The detection by evaporation on the water-bath is uncertain on account of the dissociation which sets in.—*Berichte Deutsch. Chem. Gesell.*

ON THE

USE OF MERCURY THERMOMETERS, WITH PARTICULAR REFERENCE TO THE DETERMINATION OF MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

(Concluded from p. 9).

Corrections for Thermometers with a Limited Scale.

If the points 100° and 218° or 218° and 306° are so fixed on the scale of the mercury thermometer that they exactly agree with the measures that would be obtained by a hydrogen thermometer, a different table of corrections must be used to bring determinations made on intermediate points of the scale in agreement with the hydrogen thermometer, and the following tables give these corrections for each case of a limited scale. The 1st horizontal column gives the temperatures, and the 2nd the corrections that are to be applied (taking notice of the signs + or −) to transform degrees on the mercury thermometer into two measures of temperature as determined by the hydrogen thermometer.

TABLE *No.* 1.—*Scale* 100°—218°.

Temperature—	100°	110°	120°	130°	140°	150°	160°	170°
Correction—	0·00	+0·01	+0·02	+0·07	+0·13	+0·21	+0·28	+0·29
Temperature—	180°	190°	200°	210°	218°	220°	230°	
Correction—	+0·28	+0·25	+0·19	+0·09	+0·00	−0·02	−0·12	

TABLE *No.* 2.—*Scale* 218°—306°.

Temperature—	−0·06	0·00	+0·02	+0·09	+0·15	+0·21	+0·26
Correction—	210°	218°	220°	230°	240°	250°	260°
Temperature—	270°	280°	290°	300°	306°	310°	320°
Correction—	+0·33	+0·37	+0·30	+0·15	0·00	−0·06	−0·31

As it is supposed that the thermometers intended for this use have been subjected to a preliminary treatment at 355°, no great permanent displacement of the zero point can take place in subsequent experiments, and with a limited scale the extent of the temporary depressions and elevations of the zero point is not large; however, in accurate work this point should always be observed after a measure of temperature, and a correction made for its displacement, and the above tables are adapted to results thus corrected.

In these thermometers the value of the degree is derived from a verification of the terminal points of the scale by means of boiling water, naphthalene, or benzophenone, and if these points are inexact on the mercury thermometer, all the measures must be multiplied by the fractions representing the true value of the degree. The terminal points on the scales of these thermometers are to be determined for graduation or for verification by observing first the higher temperature, and it is well to heat several hours at this temperature to avoid any considerable displacement of the zero during graduation. The lower point is then determined as rapidly as possible.

It may be noticed that the corrections are very small compared with those which are applied to the ordinary scale running from zero to 360°, and they are almost identical for all thermometers. If smaller limits are taken for the scale, and points are fixed 50° apart in accordance with a gas thermometer, the corrections are so small for the intermediate points that no series of determinations which have been thus far made with the air thermometer are accurate enough to determine them with certainty; and the agreement between the scales of different instruments, which becomes closer as the points are taken nearer together, may be considered as almost perfect when the intervals are only 50°, and sufficiently exact for all common uses when the intervals are about 100°.

*The Evaporation of the Mercury in the Thermometer.**

When the thermometer has been made entirely vacuous of air, a rapid evaporation of mercury may be observed even at 100°, when the whole of the stem is heated in steam. If the necessary precautions are taken to set aside all other influences which would change the height of the mercury column, it may be observed to fall from minute to minute when it is watched with a good micrometric telescope; and after a quarter of an hour a variation of 0·01° or 0·02° is noticed. At high temperatures the evaporation of mercury is much more rapid, and is frequently a source of great inconvenience, disturbing the observations and dividing the mercury column by the condensation in the cooler parts of the stem. The evaporation is quite appreciable in experiments which last several days, even when the mercury is only heated 10° or 20° higher than the temperature of the air. When air is left in the stem of the thermometer the evaporation of the mercury is much retarded; but even in this case, when the stem of the thermometer is heated to 250°, a loss of mercury equivalent to several tenths of a degree may take place within half an hour. If the zero point is observed after each measure of temperature, as has been recommended, the apparent sinking of temperature caused by the evaporation of the mercury does not give rise to an error.

The Purity of the Mercury in a Thermometer.

If the mercury which is used to fill a thermometer has not been well purified, or if it has not been boiled enough in the thermometer to free the bulb and stem from air adhering to their sides, the mercury column is divided by air bubbles after long use at high temperatures. Even if the air bubble is driven into the upper reservoir, another one frequently forms in the same place, and such a thermometer becomes entirely useless. Even when it is intended to leave air in the upper reservoir, the boiling ought to be carried out as in a thermometer which is to be left vacuous, and it is advantageous to boil the mercury while the thermometer is connected with a Sprengel's pump. It seems probable, from the observations that have been made with thermometers and barometers, that when a layer of air or moisture has been left between the mercury and the glass it may serve as a channel by which further quantities of air or moisture may penetrate, and inconveniences are noticed with such instruments which certainly do not occur with those which are made with great care.

According as thermometers are well or ill made in these respects every degree of excellence may be noticed between those which will not bear a single heating, even of a few minutes at 200°, without having having the column

* This phenomenon has been noticed by everyone who has paid attention to thermometric measures, and has even been mentioned in some publications; but the errors which it may entail seem sometimes to have been neglected, and it will be seen by what has been said above that the evaporation of mercury might be a permanent cause of error in the results obtained with thermometers whose stem is left open to the air when they are heated to high temperatures.

broken, and those thermometers which are so well made that they may be heated for many days at 355° without showing the slightest air bubble in the bulb. This last was the case with four out of eight thermometers heated for eleven days and nights at 355°.

The preliminary treatment of thermometers at high temperatures, which has been frequently referred to, brings out these defects in the manufacture, and those instruments which will not bear the test must be rejected.

In connection with this subject may be mentioned a paper by Mr. Wiebe.* This author has repeated and confirmed my experiments upon the diminution of the coefficient of expansion of glass which accompanies a permanent contraction of the bulb of a thermometer, and he has published a series of interesting observations on the relation between the two phenomena which are in accordance with the principal results of my experiments. On the other hand, he considers that the permanent elevation of the zero point (in other words, the contraction of the bulb) cannot be considered as principally due to the causes which I have assigned. This opinion is partly founded upon Mr. Wiebe's incorrect determinations of zero point depressions. Those published by him for the temperature 370° are probably less than one-third of the true value; and he appears also to have been misled by a theory which it will be interesting to examine. Mr. Wiebe supposes that a gas is disengaged from the glass on heating, and that a portion of the contraction of the bulb is due to this cause. He cites the experiments of Dumas, Lockyer, Miller, who have found that several metals, as well as phosphorus, give off a gas when they are strongly heated *in vacuo*.

It might be objected that these experiments would be little conclusive if it were true that glass and porcelain were like the metals in this respect, because these substances formed the material of the apparatus which was used. But let us suppose that a contraction may really result from the disengagement of a gas which fills the intermolecular spaces of glass; we may calculate the probable extent of the contraction by taking the necessary data from well-known experiments with palladium. This is the only metal with which the phenomenon has been studied with reference to the contraction of a solid body produced by a loss of gaseous material. It may be added, however, that the results would be six or eight times more favourable to the hypothesis of Mr. Wiebe if they were based upon the solution of hydrochloric acid or of ammonia in water.

Mr. Wiebe has given no measures of the quantity of gas which was observed on heating and which separated the mercury column in his thermometers. The volume of the gas can be measured when the mercury is not made to boil, and I will take the largest quantity which I have observed as a basis for a calculation. During an elevation of the zero point equal to 17°, a bubble of gas was formed on the side of the bulb; this was eventually brought into the stem, where it separated the column of mercury and filled a space equivalent to 1·35°. The contraction of the bulb was equivalent to 0·0026 part of the total volume occupied by the mercury. This latter volume may be taken as unity, and the quantity of gas disengaged was equivalent to 0·00021 part. The volume of the glass of the bulb relatively to the mercury may be taken at 0·2, which is a usual proportion in thermometers whose bulbs and mercury are weighed for specific heat determination. (The relative volume of the glass in my thermometer was really larger.) We will suppose that only half the gas is emitted into the interior of the thermometer. We will suppose that the contraction of palladium is proportional to the quantity of hydrogen disengaged. (It is really smaller when the volume of hydrogen is small.)

It would result that a diminution of volume from 1·0026 to 1·0000 would be accompanied by an evolution of more than 15 volumes of gas. Divide this number by 2 to express that only the half of the gas disengaged by the glass of the bulb appeared in the interior of the thermometer, and by 5 because the volume of the glass is supposed to be only equal to one-fifth that of the mercury, and we find that 1·5 volume of gas should be given off if the contraction were due only to this cause.

It may be concluded that the quantity of gas disengaged in the experiment most favourable to the theory of Mr. Wiebe was 7000 times smaller than the quantity required by the calculations founded on the above hypothesis, or that $\frac{1}{7000}$ of the effect is attributable to a disengagement of gas. This discrepancy becomes still greater when it is remembered that the bubble measured was not under atmospheric pressure, as assumed in the calculation, but under a much smaller pressure, and in the experiments where no gas was disengaged no part of the phenomenon is accounted for by Mr. Wiebe's hypothesis.

It may also be observed that, did the glass of a thermometer evolve a gas in sufficient quantity to account for a notable contraction of the bulb, the pressure of this gas would be quite appreciable, even in thermometers which have an upper reservoir, while in those which have none and are particularly intended for use at high temperatures, the pressure might amount to several hundred atmospheres at a moment when the stem is filled with mercury, leaving a free space of only some 50°.

I have taken the only data known regarding a solid; but, as has already been remarked, the numbers would be more favourable to the views of Mr. Wiebe if the calculation were based upon the absorption of hydrochloric acid or ammonia by water, and the discrepancy between the facts and the theory would be reduced from 7000 to 700 if the gas were supposed to be oxygen with the same density, when condensed to a liquid, as water.* But these numbers ranging in my experiments from 700 to infinity, indicate too strong probabilities against the hypothesis in question to make it worth further consideration.

This subject has been treated under the heading of "Purity of the Mercury in a Thermometer," because it is believed that the vexatious appearance of bubbles is usually due to want of care in the manufacture of thermometers. It may be added that at temperatures so high as 370°, particularly when the mercury boils, a rapid movement of the column may imprison air from the reservoir, and that wherever a bubble has once formed it is apt to reappear. Perhaps, as has been said, the *moistening* of the glass by a gas may extend to the formation of a permanent canal along the stem, between the mercury and the glass, through which gas passes, particularly when the mercury is in rapid movement. The following experiment has some bearing on the subject:—A clean capillary tube, plunged deep under the surface of mercury, serves to suck up an unbroken column of mercury; but even a short exposure of the tube to the air of a laboratory coats it with a film of chloride of ammonium, and then when the mercury is made to flow up through it, bubbles of air are drawn down between the mercury and the outside of the capillary tube, and a broken column appears in the tube. Thus, a thermometer which has not been sufficiently cleaned is particularly liable to the defect of the formation of bubbles.

The Influence of Pressure upon a Thermometer.

The most complete series of experiments upon this subject has been made by Mr. Mills, who has studied the relation between the rise of the mercury in the stem and the pressure exercised upon the bulb of the thermometer. In one series of his experiments the rise was 0·106° for every atmosphere of pressure up to 133 atmospheres.

According to Mr. Mills, an excess of pressure of 1 atmosphere causes a rise of about 0·2°; but this factor must be determined for every thermometer separately. It appears to be in inverse ratio with the thickness of the

* *Metronomische Beitrage*, No. 3.

* The theory of M. Dumas and the experiments of M. Raoul Pictet indicate the density of liquefied oxygen is about 1.

glass, but depends also upon the form of the bulb; and it is evident that a fault in the symmetry of the bulb might considerably increase the compressibility of a thermometer.

It is apparent from the above figures that the variations in the barometric pressure may be neglected from this point of view; but it is frequently necessary to take into account the differences of pressure, which depend upon whether the thermometer is placed horizontally or vertically, and, in a long thermometer, the variations of the zero, or better, of the boiling-point, which ensue upon a change of position, may be used to calculate approximately the co-efficient of compressibility of a thermometer.

Variations of this kind must be allowed for in distillations *in vacuo*, and in all similar operations where the thermometer is subjected to a diminished or increased pressure; but it is frequently preferable to avoid such corrections by placing the thermometer in a very thin tube, closed at its lower extremity and communicating with the air at its upper end. For another reason it is frequently convenient to enclose the thermometer in an extremely thin glass tube, like those which are used for making the stems of areometers, in order to prevent the black colouring matter (usually a mixture of wax and lampblack) from being dissolved away from the division marks on the scale. If the tube is thin and of nearly the same diameter as the thermometer, and a little mercury is put in the bottom to cover the bulb, the sensitiveness of the thermometer is very little diminished, and thermometers so arranged respond more quickly to change of temperature than those of the German model, which have a portion of the bulb covered by a great thickness of glass at the point where an exterior tube containing the scale is soldered to the bulb.

Distillation.

When the substance is pure, and when the above precautions regarding the use of thermometers have been observed, errors in the determination of the boiling-point arise most frequently from too hasty operations. The mercury in the bulb takes the temperature of the vapours almost immediately, but the same is not true of the mercury column in the stem, which has to be heated through a great thickness of glass, and, what is of still more consequence during this process, the liquid which is at first condensed very rapidly on the upper part of the stem runs down and cools the bulb. Even when all the mercury column is surrounded by the vapour of the boiling substance, and the apparatus is in every way well arranged to guard against loss of heat, 5 to 10 minutes are required for the temperature to become constant, and during this period the apparatus should be held in such a position that the liquid in the condensing tube may flow back, and from time to time during the distillation it is well to heat for a few moments without allowing any substance to pass over into the recipient in order to see if a constant temperature has been attained.

With substances boiling at very high temperature it is somewhat difficult to obtain a column of vapours sufficiently long to heat the stem of the thermometer without overheating the vapours near the bulb. And where the metallic apparatus before described cannot be used, the difficulty of dealing with high-boiling substances is greatly lessened by surrounding the apparatus with a jacket at least 2 c.m. in thickness of plaster-of-Paris or asbestos cloth, leaving only a portion of the bottom of the boiling vessel exposed to the flame. This portion can be usually entirely covered with the substance which is to be distilled, so that the flame does not at any point come in contact with the part of the apparatus containing the vapours. When plaster-of-Paris is used, such an apparatus must be maintained 2 or 3 hours at high temperatures before the water is evaporated out of the plaster, and in fact the moment when the apparatus is ready for use can be observed by the very much smaller flame required to maintain active ebullition. When the glass apparatus has a disengagement tube soldered into its neck the plaster must not be allowed to set at the joint; it should be scraped away from the part while soft, although the protecting jacket should be carried about 2 c.m. higher round the neck. Where a substance is known to have the same boiling-point at the beginning and at the end of a distillation, or when the quantity of a substance is too small to admit of a fractional distillation, the boiling-point may be conveniently tested in an ordinary test-tube surrounded by a plaster cylinder; for instance, if sulphur is made to boil in this way, the plaster becomes dry after 2 or 3 hours, and then the condensation takes place almost entirely on the part of the naked tube immediately above the plaster cylinder. A cylinder so prepared and dried may be slipped over other test-tubes and used for all boiling-point determinations. Experiments with such an apparatus filled with mercury or sulphur, and using an air thermometer, have shown that the boiling-point determinations are reliable to within 0·2°.

Melting-point Determinations.

When a sufficient quantity of substance can be disposed of, it is best to introduce a small and sensitive thermometer into the liquid, and to observe all the changes of temperature during the complete solidification.

It is usual to take melting-points of small quantity of matter in a capillary tube attached to a thermometer, and both are heated in a sulphuric acid bath or in a paraffin bath* for temperatures higher then 300°. It is only necessary to remark upon a modification of this process in which the apparatus contains an interior tube, which is used as an air-bath, surrounded by sulphuric acid. This form of apparatus was devised to prevent the sulphuric acid vapours from escaping into the air, and to prevent the acid from attracting moisture. These ends could be obtained more simply otherwise, and the apparatus has a grave defect. It is only necessary to heat a large and a small thermometer together in an air-bath at changing temperatures to see that one is constantly behind the other in its indications, and it is quite certain that a small mass of substance in a capillary tube would be usually heated more quickly than a thermometer placed beside it, when they are both heated in an air-bath at rising temperatures. It is therefore indispensable in melting-point determinations to heat the thermometer and the capillary tube together in a liquid, and not in any form of air-bath. The numerous forms of apparatus proposed for observing points of fusion have often been applied with good results to special cases, but the ordinary method is on the whole the most convenient, and few substances are known of sufficient purity to demand a process of greater accuracy. The method which is most nearly perfect is that which is always used with melting ice, and it would be interesting to heat such other solids as can be obtained pure in sufficient quantities in an air-bath at a temperature somewhat higher than their melting-points and to observe the degree of constancy attained by a thermometer properly surrounded by the melting solid.—*American Chemical Journal*, vol. v., No. 5.

THE NEW CHEMICAL LABORATORIES OF THE SWISS POLYTECHNIC SCHOOL AT ZURICH.

The old chemical laboratories of the Polytechnicum of Zurich having proved inadequate to accommodate the number of students resorting to that Institution in ever-increasing numbers, the Federal Parliament has just voted funds for constructing new laboratories which promise to be among the largest and finest ever erected.

* It is not difficult to find English paraffin candles which are so well purified that after distilling a small portion of the more volatile hydrocarbons it enters into active boiling above 370°.

The sum now voted (1,337,000 francs) will only cover the buildings proper, the internal fittings will cost another 300,000 to 400,000 francs, so that the total will amount to the magnificent sum of about £70,000. Nor will this money be spent to any great extent upon handsome frontages, columns, and similar ornamental appendices, as has been done in some other well-known laboratories, but the exterior is to be kept as plain as possible, all the more funds being left for making the interior as spacious, comfortable, and well-appointed as possible.

The plans of the building have been drawn by the professors of architecture, Messrs. Bluntschli and Lasius, on the lines laid down by the present professors of chemistry, Dr. Victor Meyer and Dr. Lunge. There will be a central building, 288 feet long and 67 feet wide, flanked at each end by two aisles at right angles, of 100 feet length and 38 feet width, and a similar aisle in the centre at the back, *i.e.*, altogether five aisles of an aggregate length of 500 feet. The central building will be three-storied; the aisles two-storied. They will principally accommodate the two great laboratories, that of "analytical chemistry," (Dr. V. Meyer's), for 100 students, and that of "technical chemistry" (Dr. Lunge's) for 80 students. A comparatively small portion of the building is taken up by the Institute of Pharmacy, the agricultural control station, and the assaying office for gold and silver. The whole is situated in a commanding position, a little above the Polytechnicum, with a splendid view of the Lake and the Alps. Each student will have from two to three times more room and corresponding facilities at his disposal than is at present the case in the best existing laboratories. Special care will be taken to insure the best possible ventilation by means of a powerful steam-engine, a chimney 100 feet high, and numerous small shafts for the single draught-places which will be at everybody's elbow. Motive power will be supplied, more especially for the technical laboratory, in which operations on a comparatively large scale will be possible. Special large rooms will be fitted up for dyeing, for photography, and further purposes. The whole will be finished and ready for a start in the summer of 1886, at which period the Federal Government is bound by treaty to hand over the present laboratories to the Canton of Zurich for its own use.

It seems worthy of notice that the Swiss Confederation, which numbers only two-thirds of the inhabitants of London, spends this large sum upon an institution which is freely open to all the world. Only about one-third of the students are Swiss, two-thirds are foreigners, among them a number of Englishmen and Americans.

UNIFORM ANALYTICAL METHODS.

The following letter has been sent to the members of the Society of Chemical Industry:—

Zurich, Switzerland, April, 1883.

Dear Sir,—The Committee of the German Society for the promotion of Chemical Industry has resolved, upon a suggestion made by the representative of the chemical manufacturers, to submit to the next General Meeting of the Society the following proposals, viz.:—

"That steps may be taken for bringing about an International Agreement concerning uniform analytical methods for estimating the commercial value of certain products."

I have been honoured with the request to lay a report upon this matter before the meeting, and for this purpose I take the liberty of addressing myself to you, to obtain the favour of your opinion thereon.

It will not be doubted that the confusion at present reigning in that matter is very awkward indeed. In the transactions between manufacturers and their buyers and sellers, unpleasant discussions or even lawsuits are frequently caused by the employment of different methods of sampling, or testing, or both—methods which must needs lead to differing results; and an appeal to a commercial analyst sometimes increases the confusion by the introduction of a third method. This would be avoided, if all those concerned were agreed upon employing certain standards for sampling and testing the goods, the same specific gravity tables, and so forth.

It is, moreover, most desirable that the results of analysis should be expressed in an uniform manner. Mutual understanding is greatly impeded if, for instance, one party calculates phosphoric acid as such, the second as tricalcic phosphate, the third perhaps as monocalcic phosphate. The strength of soda-ash is expressed in a different way each in England, France, and Germany, and many other similar instances might be quoted. Not merely for commercial purposes, but also for comparing results of work it would be most desirable to establish some such agreement. An English acid maker, who learns that his German neighbour consumes so much nitric acid at 36° Baumé for each cwt. of sulphuric acid, has no notion what that may mean in terms of 96 per cent nitrate of soda per 100 parts of sulphur, &c.

A considerable portion of the German chemical manufacturers have taken steps for improving this state of affairs, at least within their own country. The chemical manure makers have agreed upon uniform and binding modes of testing, and the alkali trade is aiming at the same object by means of a Manual for Alkali, Potash, and Ammonia-works, just published. The success already attained in this direction in Germany has been an encouragement to conceive the idea that the great advantage of uniform methods might be extended internationally, and it is just the object of the present communication to gather information about the possibility of realising this.

Nobody, of course, will overlook the difficulties standing in the way of such an agreement. Some of the countries concerned do not even possess suitably organised unions of chemical manufacturers, and international unions of such a character are altogether out of the question. Even if such existed, they would never succeed in *compelling* their members to employ certain methods, or even the same way of expressing the results, and still less would they be able to exert such a compulsion upon the buying and selling public and the commercial analysts. Nor can it be denied that great differences of opinion exist as to the value of many analytical methods, and that constantly new, if not always better, methods come to the fore. Hence, a rigid, compulsory code, binding for ever, or even for a long period, is not to be thought of. But, on the other hand, those go too far who for this reason deny the possibility or even the desirability of an agreement in this respect. Even in public matters no law can be made which embodies absolute truth and justice; in the long run, with changing circumstances, the best laws become unsuitable and must be changed; but nobody pretends that therefore we must do without laws altogether. Without laying too much stress upon this simile, it will be conceded that an agreement among the leading manufacturers and chemists of the great industrial countries upon the matters concerned, even though it would not either possess or claim absolute binding power, would be invested with sufficient authority to serve in a large majority of cases as a standard in the intercourse between buyers and sellers. It would soon become a regular practice to stipulate for those standards in contracts and sale notes, and they would be acknowledged as decisive in Courts of Laws.

With this view I beg to lay the following questions before you, in the respectful hope of receiving as full an answer as possible, to be made use of, either with mention of name or otherwise, as you may wish, in my report to the meeting of German chemical manufacturers.

1. Do you believe that an international agreement, concerning exact standards of *sampling* ores, raw products, and chemicals could be attained?
2. Do you believe that a similar agreement could be attained in the matter of *analytical methods*, and

more particularly in which definite branches of industry?

3. Do you believe that in some definite branches of chemical industry an uniform international *way of expressing the results* could be agreed upon, and have you any specific proposals to make in this respect?
4. In case you should answer one or more of the above questions in the affirmative, what *organs* would you think suitable for establishing an international agreement?
5. Do you think that such agreements should be made for an indefinite time, or that their *revision*, evidently called for from time to time, should be from the first provided for by a periodical action of the just mentioned organs?
6. In what *form* do you think that the results of such an agreement should be made accessible to the public?

Whatever your opinion may be upon those points, I shall consider it a special favour if you will impart it to me at your convenience, in order to make use of it in my official report.—I have the honour to be dear Sir, yours most respectfully,

George Lunge, Ph.D.
Professor of Technical Chemistry at the Federal Polytechnic School, Zurich.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ZINC.

The several determinations of the atomic weight of zinc are by no means closely concordant. The results obtained by Gay-Lussac† and Berzelius‡ were undoubtedly too low, and may be disregarded here. We need consider only the work done by Jacquelain, Favre, and Axel Erdmann.

In 1842 Jacquelain published the results of his investigations upon this important constant.‖ In two experiments a weighed quantity of zinc was converted into nitrate, and that by ignition in a *platinum* crucible was reduced to oxide. In two other experiments sulphuric acid took the place of nitric. As the zinc contained small quantities of lead and iron, these were estimated, and the necessary corrections applied. From the weights of metal and oxide given by Jacquelain the percentages have been calculated:—

Nitric Series.

9·917 grms. Zn gave	12·3138 ZnO.	80·536 per cent Zn	
9·809 ,,	12·1800 ,,	80·534	,,

Sulphuric Series.

2·398 ,,	2·978 ZnO.	80 524	,,
3·197 ,,	3·968 ,,	80·570	,,

Mean of all four, 80·541 ± 0·007

Hence Zn = 66·072 ± 0·028.

The method adopted by Axel Erdmann§ is essentially the same as that of Jacquelain, but varies from the latter in certain important details. First, pure zinc oxide was prepared, ignited in a covered crucible with sugar, and then, to complete the reduction, ignited in a porcelain tube in a current of hydrogen. The pure zinc thus obtained was converted into oxide by means of treatment with nitric acid and subsequent ignition in a *porcelain* crucible. Erdmann's figures give us the following percentages of metal in the oxide:—

80·247
80·257
80·263
80·274

Mean 80·260 ± 0·0037

Hence Zn = 64·9045 ± 0·019.

If we combine the results of Jacquelain with those of Erdmann, we get a mean percentage of zinc, 80·324 ± 0·0032; and an atomic weight of Zn = 65·168 ± 0·018. The reason for the discordance between the two experimenters will be considered further along.

Favre* employed two methods of investigation. First, zinc was dissolved in sulphuric acid, the hydrogen evolved was burned, and the weight of water thus formed was determined. To his weighings I append the ratio between metallic zinc and 100 parts of water:—

25·389 grms. Zn gave	6·928 grms. H_2O.	366·469
30·369 ,,	8·297 ,,	366·024
31·776 ,,	8·671 ,,	366·463

Mean 366·319 ± 0·088

Hence Zn = 65·803 ± 0·020.

The second method adopted by Favre was to burn pure zinc oxalate, and to weigh the oxide and carbonic acid thus produced. From the ratio between these two sets of weights the atomic weight of zinc is easily deducible. From Favre's weighings, if CO_2 = 100, ZnO will be as given in the third column below:—

7·796 grms. ZnO =	8·365 grms. CO_2.	93·198
7·342 ,,	7·883 ,,	93·137
5·2065 ,,	5·588 ,,	93·173

Mean 93·169 ± 0·012

Hence Zn = 65·8395 ± 0·022.

A fourth combustion of the oxalate is omitted from the above series, having been rejected by Favre himself. In this the oxide formed was contaminated by traces of sulphide.

The four values for zinc now before us are so discordant that a combination of them after the usual method can have only a trifling significance. The following is the result thus obtained:—

From Jacquelain's figures ..	Zn = 66·072 ±	0·028
From Favre's water series ..	,, 65·803	0·020
From Favre's oxalate series..	,, 65·8395	0·022
From Erdmann's figures ..	,, 64·9045	0·019
General mean	,, 65·557	0·011

It will be seen that three of these values agree tolerably well, placing the atomic weight of zinc in the neighbourhood of 66, while the other is, in round numbers, about a unit lower. This lower figure, however, has the smallest probable error, and it will be found also, npon careful consideration, that it is less likely than the others to be vitiated by experimental inaccuracies. Both chemically and mathematically it is the best.

Upon comparing Erdmann's results with those of Jacquelain two points are worth noticing: first, Erdmann worked with purer material than Jacquelain, although the latter applied corrections for the impurities which he knew were present; secondly, Erdmann calcined his zinc nitrate in a porcelain crucible, while Jacquelain used platinum. In the latter case it has been shown that portions of zinc may become reduced and alloy themselves with the platinum of the crucible. Hence a lower weight of oxide from a given quantity of zinc, a higher percentage of metal, and an increased atomic

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Mémoire d'Arceuil*, 2, 174.
‡ *Gilb. Annal.*, 37, 460.
‖ *Compt. Rend.*, 14, 636.
§ *Poggend. Annal.*, 62, 611. *Berz. Lehrb.*, 3, 1219.

* *Ann. Chim. Phys.*, (3,) 10, 163. 1844.

weight. This source of constant error has undoubtedly affected Jacquelain's experiments, and vitiated his results. In Erdmann's work no such errors seem to be present.

Over Favre's experiments Erdmann's have the important merit of simplicity. In the latter it is difficult to detect sources of error; in the former it is easy. In Favre's water series it was essential that the hydrogen should first be thoroughly dried before combustion, and then that every trace of water formed should be collected. A trivial loss of hydrogen or of water would tend to increase the apparent atomic weight of zinc.

In the combustion of the zinc oxalate equally great difficulties are encountered. Here a variety of errors are possible, such as are due, for example, to impurity of material, to imperfect drying of the carbon dioxide, and to incomplete collection of the latter. It may not be easy to prove that such errors actually did creep into Favre's work, and yet their possibility hinders us from absolutely accepting his results.

All things considered, then, Erdmann's determination of the atomic weight of zinc is the one most entitled to credit, and must be taken for the present in lieu of the general mean deduced from all four of the values. This determination, $Zn = 64{\cdot}9045 \pm 0{\cdot}019$, becomes, if $O = 16$, $65{\cdot}054$.

The following additional note has been communicated by the author:—

Marignac has very lately re-determined the atomic weight of zinc by a complex process depending upon the complete analysis of the double salt $ZnCl_2.2KCl$. In eight experiments the mean value obtained is $Zn = 65{\cdot}305$. (With $O = 16$, and Stas's values for As, K, and Cl). Marignac objects to Erdmann's results on the ground that ZnO resulting from the calcination of the nitrate always contains nitrous impurities. This would render Erdmann's determination too low. (*Arch. des Sci. Phys. et Nat.* (3), 10, 194).—F. W. C.

CADMIUM.

The earliest determination of the atomic weight of this metal was by Stromeyer, who found that 100 parts of cadmium united with 14·352 of oxygen.* With our value for the atomic weight of oxygen these figures make $Cd = 111{\cdot}227$. This result has now only a historical interest.

The more modern estimates of the atomic weight of cadmium are four in number, by v. Hauer, Lenssen, Dumas, and Huntington. Of these that by v. Hauer† comes first in chronological order. He heated pure anhydrous cadmium sulphate in a stream of dry hydrogen sulphide, and weighed the cadmium sulphide thus obtained. His results were as follows, with the percentage of CdS in $CdSO_4$ therefrom deduced:—

7·7650 grms. $CdSO_4$ gave	5·3741 CdS.	69·209 per cent.
6·6086 ,,	4·5746 ,,	69·222 ,,
7·3821 ,,	5·1117 ,,	69·245 ,,
6·8377 ,,	4·7336 ,,	69·228 ,,
8·1956 ,,	5·6736 ,,	69·227 ,,
7·6039 ,,	5·2634 ,,	69·220 ,,
7·1415 ,,	4·9431 ,,	69·217 ,,
5·8245 ,,	4·0335 ,,	69·251 ,,
6·8462 ,,	4·7415 ,,	69·257 ,,
		Mean 69·231 ± 0·0042

Lenssen‡ worked upon pure cadmium oxalate, handling however only small quantities of material. This salt, upon ignition, leaves the following percentages of oxide:—

0·5128 grm. oxalate gave	0·3281 CdO.	63·982 per cent.
0·6552 ,,	0·4193 ,,	63·996 ,,
0·4017 ,,	0·2573 ,,	64·053 ,,
		Mean 64·010 ± 0·014

Dumas* dissolved pure cadmium in hydrochloric acid, evaporated the solution to dryness, and fused the residue in hydrochloric acid gas. The cadmium chloride thus obtained was dissolved in water and titrated with a solution of silver after the usual manner. From Dumas's weighings I calculate the ratio between $CdCl_2$ and 100 parts of silver:—

2·369 grms. $CdCl_2$ =	2·791 grms. Ag.	84·880
4·540 ,,	5·348 ,,	84·892
6·177 ,,	7·260 ,,	85·803
2·404 ,,	2·841 ,,	84·618
3·5325 ,,	4·166 ,,	84·794
4·042 ,,	4·767 ,,	84·791
		Mean 84·843 ± 0·026

Latest of all comes Huntington's† work done under the direction of Professor J. P. Cooke. Bromide of cadmium was prepared by dissolving the carbonate in hydrobromic acid, and the product, dried at 200°, was purified by sublimation in a porcelain tube. Upon the compound thus obtained two series of experiments were made.

In one series the bromide was dissolved in water, and a quantity of silver not quite sufficient for complete precipitation of the bromine was then added in nitric acid solution. After the precipitate had settled, the supernatant liquid was titrated with a standard solution of silver containing 1 grm. to the litre. The precipitate was washed by decantation, collected by reverse filtration, and weighed. To the weighings I append the ratio between $CdBr_2$ and 100 parts of silver bromide:—

Grms.	Grms.	
1·5592 $CdBr_2$ gave	2·1529 AgBr.	Ratio 72·423
*3·7456 ,,	5·1724 ,,	72·415
2·4267 ,,	3·3511 ,,	72·415
*3·6645 ,,	5·0590 ,,	72·435
*3·7679 ,,	5·2016 ,,	72·437
2·7938 ,,	3·8583 ,,	72·410
*1·9225 ,,	2·6552 ,,	72·405
3·4473 ,,	4·7593 ,,	72·433
		Mean 72·4216 ± 0·0028

The second series was like the first, except that the weight of silver needed to effect precipitation was noted, instead of the weight of silver bromide formed. In the experiments marked with an asterisk, both the amount of silver required and the amount of silver bromide thrown down were determined in one set of weighings. The third colvmn gives the $CdBr_2$ proportional to 100 parts of silver:—

*3·7456 grms. $CdBr_2$ =	2·9715 grms. Ag.	126·051
5·0270 ,,	3·9874 ,,	126·072
*3·6645 ,,	2·9073 ,,	126·045
*3·7679 ,,	2·9888 ,,	126·067
*1·9225 ,,	1·5248 ,,	126·082
2·9101 ,,	2·3079 ,,	126·093
3·6510 ,,	2·8951 ,,	126·110
3·9782 ,,	3·1551 ,,	126·088
		Mean 126·076 ± 0·0052

From the first series ..	$CdBr_2$ =	271·498 ±	0·032
From the second series ..	,,	271·505	0·027
General mean	,,	271·502	0·0215

Hence $Cd = 111{\cdot}966 \pm 0{\cdot}043$.

* See Berzelius's "Lehrbuch," 5th Ed., 3, 1219.
† *Journ. f. Prakt. Chemie*, 72, 350. 1857.
‡ *Journ. f. Prakt. Chem.*, 79, 281. 1860.

* *Ann. Chem. Pharm.*, 113, 27. 1860.
† *Proc. Amer. Acad.*, 1881.

According to Huntington's own calculations these experiments fix the ratio between silver, bromine, and cadmium as Ag : Br : Cd :: 108 : 80 : 112·31. This result militates strongly against Prout's hypothesis.

Upon combining all the determinations we get the following result:—

v. Hauer	Cd =	111·684	± 0·040
Lenssen	,,	111·803	0·062
Dumas	,,	111·969	0·065
Huntington..	,,	111·966	0·040
General mean ..	,,	111·835	0·024

Or, if O = 16, then Cd = 112·092.

It will be seen that Dumas and Huntington's determinations both made with haloid salts of cadmium, agree with wonderful closeness, and so confirm each other. On the other hand, v. Hauer's data give a value for the atomic weight of cadmium which is much lower. Apparently v. Hauer's method was good, and the reason for the discrepancy remains to be discovered. Until it is ascertained I prefer to use the above mean value for Cd, rather than to adopt one investigation and reject the others.

CORRESPONDENCE.

VAPOUR-PRESSURE OF MERCURY.

To the Editor of the Chemical News.

SIR,—Mr. R. B. Warder's criticisms are very just, and the difficulties that have occurred to him presented themselves to me when the experiments were first commenced. I endeavoured, however, to facilitate the diffusion of the mercury vapour in the air of the flask by hanging the tube just at the bottom of the neck, and also by filling the tube brim-full of mercury, so that the meniscus was level with the edge of the tube. These details ought to have been stated in the paper.

The first experiment was to me very inconclusive, and it was only the very concordant result obtained by the second, under the conditions of prolonged time and increased mercury surface, that made me think the result worthy of record,—I am, &c.,

HERBERT MCLEOD.

Cooper's Hill, January 5, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 24, December 10, 1883.

A New Compound of Rhodium.—H. Debray.—On fusing finely-divided rhodium with twenty or thirty times its weight of iron pyrites, the author obtained a regulus which, when treated with hydrochloric acid, leaves a deposit of black scales of a semi-metallic appearance. This deposit, whilst still moist, is entirely soluble in dilute nitric acid. This product is not a rhodium sulphide, but contains about 9·6 per cent of water, 17·2 of sulphurous acid, or 8·6 of oxygen, and 73·2 of rhodium sulphide. A new study of the amorphous residues obtained on dissolving the regulus of iron pyrites and the metals of the platinum group is necessary.

Formulæ showing the Electric Resistance of the Circuit employed in Edison's System of Lighting.—G. Gueroult.—A purely mathematical paper.

Researches on the Solidification of Superfused Sulphur (Second memoir).—D. Gernez.—Sulphur which has been heated to near 170° undergoes a modification which persists when it is caused to remain in the superfusion bath, and it is remarkable to note that if the temperature has been raised much above 170°, although the liquid again passes by this temperature when it is brought into the superfusion-bath, it crystallises as rapidly as if it had been heated to a temperature little higher than the point of fusion.

Determination of the Atomic Weight of Aluminium by Means of its Sulphate.—M. Baubigny.—The author's mean result is Al = 13·508 if S = 16, and Al = 13·532 if S = 16·037.

Formation of Acetylene at the Expense of Iodoform.—P. Cazeneuve.—If iodoform is intimately mixed with moist powdered silver, it rapidly yields acetylene, even in the cold.

Moniteur Scientifique, Quesneville. December, 1883.

Patents obtained Abroad.—Abstracts of specifications, chiefly German, relating for the most part to the manufacture of coal-tar colours.

The Manufacture of Aluminium.—W. Weldon.—From the *Journal of the Society of Chemical Industry.*

Salt Works of Giraud en Camargue.—Professor G. Lunge.—A very full account of a visit to the "salines" of Péchiney and Co., in the island of Camargue between the two main mouths of the Rhône. After sodium chloride has been obtained from the salt water, the mother-liquors serve for the extraction of salts of potassium and magnesium, and for the manufacture of sodium sulphate. The marketable products are anhydrous sodium sulphate, magnesium sulphate, potassium chloride, and certain mother-liquors, which, if needful, may be treated further for the extraction of bromine. The potassium chloride is used partly as manure, and partly in the manufacture of potassium chlorate.

The Helvetic Society.—At the 66th meeting of this Society the chemical section was presided over by Prof. Wislicenus. Prof. V. Meyer, of Zurich, gave an address on the nature of the chemical elements according to recent researches. He discussed the possibility of a decomposition of the so-called elements, but admitted that for the present it had not been possible to resolve any element into substances qualitatively different.

Prof. Krafft, of Bâle, exhibited certain of the higher alcohols of the series $C_nH_{2n+2}O$, and added some remarks on the series of alcohols in general.

Prof. L. Soret, of Geneva, gave a summary of his researches on the absorption of the ultra-violet rays by various substances of animal origin.

Dr. M. Céresole, of Lausanne, read a paper on the acetacetic acids.

Prof. V. Meyer exhibited apparatus for the determination of the density of gases at very high temperatures. He exhibited also the thiophene which he has discovered in coal-tar benzol.

Prof. Schulze, of Zurich, described researches which he had undertaken in common with M. J. Barbieri, on phenyl-amido-propionic acid, and also spoke concerning certain substances which enter into the composition of the cheese of Emmenthal, such as caseoglutine, leucine, tyrosine, and zinc lactate.

Prof. Wislicenus gave a communication on the relation which exists between the optical rotatory power of the carbides of hydrogen, and the existence of an atom of non-symmetric carbon. He also discoursed on the products of the reaction of phthalyl dichloride with a sodium compound of malonic ether.

Prof. E. Schaer, of Zurich, gave a historical communication on the researches of F. L. Desaive, a pharmacist, of Liège, who flourished in the last century.

Dr. H. Goldschmidt discussed the action of hydroxylamine upon the quinones.

Dr. E. Schuhmacher-Kopp related certain observations made by him as "cantonal chemist" at Lucern.

Prof. G. Lunge, of Zurich, spoke concerning the formation of sulphuric acid in the lead chambers, basing his remarks on results obtained at his instigation by M. Naef at the Uetikon works.

Dr. Urech spoke on the relation which exists between the chemical mass and the speed of reaction during the reduction of Fehling's liquid by invert-sugar. He discussed also the action of certain salts on the speed of inversion of saccharose, and described certain experiments undertaken to show that the constants of the speed of inversion depend on the nature of the acids employed. He also exhibited a lamp fed with petroleum ether.

M. Raoul Pictet read a communication on the manufacture of wood-paste by the use of sulphurous acid and of low temperatures.

Industrial Society of Mulhouse: Meetings of the Chemical Committee.—Meeting of September 12, 1883.—It was noted that the fixation of colours by means of gelatine was due, not to M. Fauquet, but to M. Lucas, chemist to the firm of Fauquet.

MM. Schlieper and Baum make certain corrections in their memoir on direct printing with indigo. The alumina is not in the gelatinous state, but is a dry hydrate. The authors prefer the soft Java indigoes to the harder Bengal sorts, although the latter are richer in indigotine.

The Committee received from M. Rotondi two pamphlets, "On the Electro-decomposition of Cadmium Chloride and the Industrial Applications of this Reaction," and on "The Action of Electrolysis upon a Solution of Pyrogallic Acid."

Meeting of October 16.—MM. Noelting and Wild have studied amido-azo-β-naphthaline.

MM. Noelting and Forel have prepared amido-azometa-xylol.

Biological Society.—Meeting of November 9.—An account of the French expedition to Egypt for the study of the cholera.

Electric Experiments at Brussels.—Experiments on the economy of the Gramme accumulator for lighting purposes and for traction. The results are described as satisfactory.

Insoluble Phosphates.—F. J. Lloyd.—From an English source.

Use of Boric Acid and Hematoxyline in Alkalimetry.—A. Guyard.—The author proposes to employ the boric acid in place of the sulphuric acid as a standard, easily procured in a state of purity, and by which it is easy to prepare a truly normal sulphuric acid. As indicator he proposes hæmatoxyline. It must be dissolved in distilled water immediately before being wanted. The solution thus obtained may serve for a day, but not longer. With this indicator the distinction between strong and weak acids disappears, boric acid producing as decided a change of colour as sulphuric acid. A few drops of a weak solution of hæmatoxyline give, with any acid liquid whatever, a light yellow colour perfectly distinct. Alkalies turn the colour to a distinct and relatively permanent purple. Hæmatoxyline is also, according to the author, one of the most delicate reagents for ammonia, and may perhaps even prove more valuable than Nessler's reagent. If traces of ammonia exist in a liquid, then, at the moment of the saturation of an acid by an alkali, the yellow tint of the hæmatoxyline is turned to a delicate violet by the formation of hæmateine. The author considers that this reaction will be of especial value in the alkalimetric determination of nitrogen.

Preparation of the Nitro-molybdic Reagent at its Maximum Concentration.—A. Guyard.—The author dissolves in a large beaker ammonium molybdate, in powder or in crystals, until it is no longer taken up on stirring. The liquid thus prepared is strongly acid to litmus. He places then in smaller glasses 15 to 20 c.c. of a nitric acid made up of equal measures of the strongest acid and of water. He then pours gradually, and with constant stirring, the ammonium molybdate into the acid until the white precipitate, which is formed and disappears, renders the liquid slightly milky. It is then cleared by the addition of a drop of nitric acid, and left to become completely cold. By each such operation there are produced 125 to 150 c.c. of the reagent at its maximum concentration. It is not judicious to attempt the preparation of larger quantities in one and the same glass.

Detecting Bismuth in Commercial Lead, and Manganese in Zinc Ash, Calamine, and Commercial Zinc.—A. Guyard.—This paper will be inserted in full.

The Golden Sulphide of Antimony and the Caoutchouc Industry.—V. Roussel.—Not adapted for useful abstraction.

An Explosion of Dynamite.—An account of an explosion which took place at the Paulilles works on January 25, 1883, proving fatal to all the persons present, who were for the most part reduced to small fragments, and scattered over a space of 150 to 200 metres. A house situate at 400 metres from the works was fractured from top to bottom, though the trees which separated it from the works were not at all damaged. (A feature which should be remembered by the authorities before licensing works for the manufacture of explosives in the neighbourhood of dwelling houses, &c.)

Archives Neerlandaises des Sciences Exactes et Naturelles,
Tome xviii., Part 4.

A Contribution to the Knowledge of Quinovic Acid, Quinovine, and Quinovite.—A. C. Oudemans, Jr.—The author's observations upon α-quinovine agree with those of MM. Liebermann and Giesel. This compound, under the influence of acids, is split up into quinovic acid and a kind of sugar, which the author calls quinovite. He has not been able to confirm Rochleder's observation that the same decomposition is effected by sodium amalgam. M. Oudemans considers that the composition of quinovic acid is best expressed by the formula $C_{33}H_{52}O_6$. Quinovite is not identical with mannitane, as Berthelot assumes. Its composition may be provisionally stated as $C_6H_{12}O_4$. It is dextro-rotatory, and is very easily oxidised by nitric acid, with abundant formation of oxalic acid. Amongst the products formed by the action of sulphuric acid upon quinovic acid was a small quantity of a compound, probably identical with the quino-chromine of Liebermann and Giesel, and, on one occasion, there was found a very small quantity of a hydrocarbon which the author calls quinovine. Another product obtained from the alcoholic mother-liquor of quino-chromine is apoquinovic acid, to which the author ascribes the formula $C_{16}H_{26}O_4$.

Diffusion of Certain Organic and Inorganic Compounds.—J. D. R. Scheffer.—A long and important paper, but incapable of useful attraction.

Justus Liebig's Annalen der Chemie,
Vol. 221, Part 3.

Communications from the Chemical Laboratory of the University of Erlangen.—These consist of a memoir by E. Fischer and H Kuzel on the hydrazines of cinnamic acid; a paper by L. Knorr on piperyl-hydrazine; an account of the hydrazine compounds of phenol and anisol, by Herm. Reisenegger, in which the author remarks that the hydrazines are chiefly distinguished from the amine bases by their want of stability in presence of oxidising agents; a paper by H. Gevekoht on the preparation of the three nitro-aceto-phenones; and a memoir by Emil Fischer and L. Reese on caffeine, xanthine, and guano.

Communications from the Chemical Laboratory of Griefswald.—We have here a paper by Dr. A. Heffter on para-amido-toluol-ortho-thio sulphonic acid, and a memoir by Dr. W. Paysan on ortho-amido-toluol-para-thio-sulphonic acid.

Methyl-arbutine, Benzyl-arbutine, and Benzyl-dioxy-benzoles.—H. Schiff and G. Pellizzari.—The authors have succeeded in converting natural arbutine into benzyl-arbutine, and in obtaining from it methyl-arbutine in pure crystals, which are evidently identical with artificial methyl-arbutine.

Cosmos les Mondes.
No. 12, November 17, 1883.

Atomic Movements.—Marcellin Langlois.—A mathematical paper, not capable of useful abstraction.

MEETINGS FOR THE WEEK

Monday, Jan. 14th.—London Institution, 5.
— Medical, 8.30.
Tuesday, 15th.—Royal Institution, 3. "Coins and Medals," by Mr. R. S. Foote.
— Institute of Civil Engineers, 8.
— Pathological, 8.30
Wednesday, 16th.—Society of Arts, 8.
— Meteorological, 7. (Anniversary.)
Thursday, 17th.—London Institution, 7.
— Royal, 4.30.
— Philosophical Club, 6.30
— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
— Chemical, 8. "On Camphoric Peroxide and Camphorate of Barium," by C. T. Kingzett. "On the Decomposition of Silver Fulminate by Hydrochloric Acid," by E. Divers, M.D., and Michitada Kawakita, M.E.; "Supplementary Note on Liebig's Production of Fulminating Silver without the use of Nitric Acid," by Edward Divers M.D., and Michitada Kawakita, M.E. "On Hyponitrites," by Edward Divers, M.D., and Tamemasa Haga.
Friday, 18th.—Royal Institution, 9. "Rainbows," by Prof. Tyndall.
Saturday, 19th.—Royal Institution, 3 "Life and Literature under Charles I.," by Prof. Morley.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1260.

VOLUMETRIC ESTIMATION OF MANGANESE.

By ALEX. J. ATKINSON.

In the Chemical News, vol. xlix., p. 9, Mr. Holdich suggests a modification of the indirect method of estimating manganese in spiegeleisen. It may be a matter of some interest that, when chemist to the Blaenavon Company, I used, for over three years, precisely the same method of estimating manganese in spiegeleisen, containing as a rule 20 per cent of manganese, and that, unless I am greatly mistaken, the same method is in regular use in the Dowlais Laboratory, where I believe I first saw it.

Having found by comparison with gravimetric determinations that the results were uniformly from 0·2 to 0·5 per cent too low, I felt justified in passing several thousands of tons of speigeleisen upon the basis of these determinations, the laboratory results being well borne out by those obtained at the Bessemer works. In the event, however, of any sample yielding by the method in question less manganese than 0·5 per cent below the amount guaranteed, a check determination was made by the gravimetric method, and, to the best of my remembrance, in each case gave results between 0·2 and 0·5 per cent above what had been found by the indirect method. I have adopted the same method for the estimation of manganese in samples of ferromanganese containing from 60 to 70 per cent of that metal, by deducting (per cent Fe + per cent Si + 6) from 100. The results were, however, by no means so regular as in the case of spiegeleisen: one cause of the irregularity being the difficulty of thoroughly dissolving the ferromanganese. More carbon being present in the ferromanganese, more hydrocarbons are liberated during its solution, and these of a more oily nature than in the case of spiegeleisen. This oily matter adheres to the small particles of the alloy, retains bubbles of hydrogen gas, and is thus the means of a portion of the fine powder being carried to the surface, and withdrawn from the solvent action of the acid. With ferromanganese I have found variations to the extent of over 1 per cent, the results being higher than those given by the gravimetric method.

For steel works, where absolute accuracy is not essential, I consider that the indirect method, when the variation in the percentage of silicon is taken into account, is well adapted, but I would not, of course, recommend it for use by commercial analysts.

With regard to the estimation of silicon I have, both on account of rapidity and of freedom from hydrochloric acid fumes, preferred the following method to the one mentioned by Mr. Holdich. It is applicable to pig-iron, spiegeleisen, steel, or wrought-iron, and gives, with considerably less trouble, a purer residue of silica than is obtained by the hydrochloric acid method. A dilute solution of sulphuric acid is prepared by mixing with six volumes of water, one volume of strong pure sulphuric acid; in this dilute acid the material is dissolved. 1·5 or 2 grms. of spiegel, &c., are dissolved in 22 or 30 c.c. of the dilute sulphuric acid in a covered beaker on a hot plate; when all the metal is dissolved, the cover is washed and removed, and the solution evaporated, rapidly at first and more cautiously as soon as the granular ferrous sulphate begins to separate out. During the latter portion of the evaporation occasional shaking is necessary to avoid the formation of a crust over the surface, which would retard further evaporation. When this evaporation is carried out with due care, the ferrous sulphate sets quite firm upon the bottom of the beaker, and the whole of the water may be driven off. When dry the ferrous sulphate is allowed to cool, and is then dissolved in hot water, boiled, and filtered through a washed filter. The silicon and graphite collected on the filter are then well washed, dried, and ignited at a bright red heat over a burner, or preferably in a muffle. The silica thus obtained is practically pure, and contains no oxide of iron, as is frequently the case with the silica obtained by dissolving in hydrochloric acid. An advantage of this method is the rapidity with which the hot solution of ferrous sulphate may be filtered and washed, whereas when hydrochloric acid is employed the ferrous chloride solution is more largely converted into ferric chloride, a solution of which filters exceedingly slowly. In conclusion, I may add that I claim no originality for this method, for I know it to be in use in other laboratories, notably at Dowlais.

44, Loudoun Square, Cardiff,
January 5, 1884.

INFLUENCE OF TIME IN FERTILISER ANALYSES.

By ROBERT B. WARDER.

The estimation of "reverted phosphoric acid" is acknowledged to be one of the most unsatisfactory parts of an analysis of commercial fertilisers. Since a somewhat arbitrary distinction must be made, it is very desirable to secure uniformity by having some definite standard that will meet with general acceptance among chemists engaged in these analyses; and in this respect, at least, the "Washington method" with neutral citrate of ammonia has had its merits. The conditions were so defined, however, by the convention of 1880, that the solvent action must often be arrested *while it is still progressing with considerable rapidity*; so that small variations in the time and temperature of action will make great variations in the result obtained. The proof of this statement will be found in a reprint sent herewith. Is it not time to seek a method (or modification of an existing method) which shall meet the general approval of chemists, and be free from this radical source of error? Correspondence is respectfully invited.

Office of State Chemist, Purdue University,
Lafayette, Ind., December 1, 1883.

*Influence of Time in Fertiliser Analyses.**

By Robert B. Warder.

Mr. H. A. Huston has examined the "influence of time and temperature on the amount of phosphoric acid dissolved from commercial fertilisers by citrate of ammonium."† From a sample of raw bone fertiliser containing 20·28 per cent P_2O_5, ammonium citrate solution of 1·09 sp. gr. at 40° C. dissolved—

In 30 minutes,	4·01	per cent P_2O_5.
45 ,,	4·97	,, ,,
60 ,,	5·92	,, ,,

Each of these values is a mean of three gravimetric determinations.

The solution was evidently incomplete. The chemical operations involved are somewhat obscure. Since a very large excess of citrate was present (about 40 mol. citrate to one of phosphate), we may apply the hypothesis that the rate of solution at each moment is proportional to the phosphoric acid still present that is capable of being so dissolved, or—

* From *Scientific Proceedings of the Ohio Mech. Inst.*, 2, 134 to 139 (1883).

† *Indiana Agricultural Report for* 1882, pp. 230 to 233.

$$\frac{-du}{dt} = au,\text{* and}$$

$$\log.\frac{u_0}{u} = At.$$

According to this hypothesis, the most probable value for the limit of solubility, under the conditions of the experiment, is 7·8 per cent of the raw phosphate, or 38 per cent of the total phosphoric acid. For the calculated values below, A = 0·0107.

Time.	Percentage of P_2O_5 dissolved. Observed.	Calculated.	Difference.
30 mins.	4·01 (mean)	3·91	0·10
45 ,,	4·97 ,,	5·05	0·08
60 ,,	5·92 ,,	5·86	0·06

The differences in this table are far less than those which appear in the several determinations upon which the means are based; yet this apparent agreement is no real proof of the hypothesis proposed or of the limit deduced, for which further experiments would be required. Mr. Huston very aptly emphasises the importance of a uniform scale of time and temperature for determinations of reverted phosphoric acid. Some chemists are inclined to discard the citrate method entirely as unreliable. The "reverted phosphoric acid" is very objectionable, since it implies a previous solubillty; but some test for relative present solubility is demanded by dealer and consumer. Far more concordant results can be expected if the reagent used is allowed to act until the limit is nearly reached, than if the time and temperature adopted allow but fifty or seventy-five cent of the soluble matter to be taken up. It will be seen, for example, from Mr. Huston's figures, that an error of a single minute in the time of action at 40° would result in an error of more than 0·06 per cent "reverted phosphoric acid." The "Washington method"† requires an exposure of the fertiliser to a solution of ammonium citrate at the ordinary temperature for an indefinite time (during elutriation, grinding, &c.), after which the "flask is put into a cold water-bath, the temperature is rapidly raised to 40° C., and there maintained for one half-hour." Under such conditions, great variations in the analytical results are inevitable. A summer temperature of 30° C. (according to Mr. Huston's results) effects solution about two-thirds as rapidly as at 40°; while the interval required to bring the temperature to 40° will vary greatly according to the size of the water-bath and many other conditions. As a hint toward more accurate experiments in this direction, the hypothesis and figures stated above would indicate the solution of 7·6 per cent of P_2O_5 in nine and three-quarter hours, while 7·02 per cent (or nine-tenths of the whole amount) would be dissolved in two-and-a-half-hours.

The desired uniformity of method for official analyses in the several States has not yet been secured:‡ a careful study of the dynamical phase of the problem may contribute to the selection of suitable conditions.

Electric Resistance of Rarefied Air.—Professor Edlund.—The author maintains that a vacuum is a good conductor of electricity. The obstacle to the passage of the current lies in the resistance of the electrodes, which he accordingly suppresses.—*Les Mondes*, No. 14, 1883.

* This equation is explained and discussed in the paper on "Urech's Investigation of the Speed of Inversion of Cane-sugar, *Proc. Ohio Mech. Inst.*, 1, 167 to 178 (Dec., 1882).

† *Proceedings of Convention of Agricultural Chemists*, held at Washington, D.C., July 28, 1880.

‡ The New Jersey law specifies a temperature under 38° C. (100° F.) for the solution of reverted phosphoric acid, with no limitation in regard to time. In a very interesting investigation conducted by the N. C. Agricultural Experiment Station, "the cold flasks were put into the bath warmed to 40° C., and left there forty minutes," in order to secure a "temperature of 40° C. in the contents of the flask for about thirty minutes." (See Report for 1882, p. 51.) Results so obtained may be comparable among themselves, but are likely to differ from those of other observers.

NOTES ON THE SEPARATION OF TELLURIUM AND SELENIUM FROM EACH OTHER, AND THEIR PREPARATION FROM LEAD-CHAMBER DEPOSIT.*

By MASACHIKA SHIMOSÉ,
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The deposit formed in the lead-chamber during the manufacture of sulphuric acid from volcanic sulphur—consisting of the ordinary yellow kind mixed with the red variety, *seki-riu-seki*, a variety containing tellurium and selenium—has been already described by Principal Divers and myself. The examination of this deposit has led me to observe several facts which are, I believe, new to the subject, and these, together with an account of my treatment of the deposit for its analysis and for the preparation from it of tellurium and selenium, I describe in this communication.

Preparation of Tellurium and Selenium from the Deposit.

Several accounts have been published of the treatment of seleniferous flue-dust and lead-chamber mud, and these have helped to guide me in my work; but my attention has been more especially directed towards getting the tellurium out of the mud.

The mud separated by subsidence into a red sediment and a yellow liquor, both containing tellurium and selenium.†

Treatment of the Sediment.—The sediment consisted principally of ashes and lead sulphate. The sulphuric acid present in it having been more than neutralised with sodium carbonate, the selenium was removed by digesting it with concentrated solution of potassium cyanide (Nilson) at a gentle heat for some time, and then diluting the mixture with water, and heating nearly to boiling. I have found that the solution should be used nearly cold at first, as otherwise the selenium agglutinates, and then obstinately resists the action of the cyanide. For this reason, Crookes's direction to boil with cyanide for eight hours, in separating selenium from tellurium, may be altered with advantage to the direction to digest at only a gentle heat for some time. Dilution was made before heating to boiling, in order that the tellurium should be less attacked by the cyanide. The cyanide solution having been decanted, the sediment was washed by subsidence and by filtration, which proved a tedious operation. After this treatment, it was strongly acidified with sulphuric acid, and a very little nitric acid added, by which means the tellurium dissolved, this substance being, as is well known, oxidisable by cold dilute nitric acid, and its hydroxide liable to separate out unless enough sulphuric acid be present. The sulphuric acid also kept the lead sulphate insoluble. In this way, a solution of tellurium almost, if not quite, free from selenium was obtained, and through it hydrogen sulphide was passed. The tellurium sulphide was fused with potassium cyanide, and the tellurium afterwards precipitated by a current of air from the aqueous solution of the fused mass, in the usual way. The solution of selenium in potassium cyanide, previously obtained, yielded its selenium when treated with hydrochloric acid.

Treatment of the Sediment for Tellurium only.—Selenium being but little acted upon by nitric acid in the cold, it proved very advantageous for getting tellurium to treat the sediment at once with sulphuric and nitric acids, except for the fact that filtration and settling are much more tedious in the presence of undissolved selenium than in its absence. The sulphuric acid was needed, as before, to keep the oxidised tellurium in solution, and the lead sulphate out. The quantity of nitric acid used was very small—only 100 c.c., sp. gr. 1·42, to the sediment of 4 to 5 kilos. of the mud. The sulphuric acid for the same

* Communicated by Dr. Divers.

† Chemical News, vol. xlviii., p. 283.

quantity was less than 300 c.c. The dissolution was complete in about seven days, when the solution was washed out, evaporated to expel nitric acid, diluted with water, and the tellurium with a little selenium thrown down by hydrogen sulphide. The sulphides were treated with cyanide and air in the usual way for getting tellurium free from selenium.

Treatment of the Yellow Liquor of the Mud.—The yellow liquor of the mud was a ready and more convenient source of tellurium than the sediment. The quantity of selenium in it was only two-fifths that of the tellurium. Ferric sulphate being present in some quantity, I found the use of sulphur dioxide for precipitating somewhat interfered with. The tellurium and selenium were therefore separated from the liquor by means of hydrogen sulphide, and the sulphides treated by Oppenheim's method.

Analyses of the Sediment and of the Liquor.—These hardly need special notice. I will only mention that, for analytical purposes, I began by treating the washed sediment with nitro-hydrochloric acid, thus getting into solution, together, all the tellurium, selenium, and lead. The rest of the treatment presented nothing new or important to record.

Some Evidence of the Existence of Telluro-cyanate. Incompleteness of the Separation of Tellurium from Selenium by Potassium Cyanide.

It was shown many years ago by Crookes that selenium combines with potassium cyanide to form seleno-cyanate, and that from this compound the selenium is wholly set free by hydrochloric acid. At the same time he found tellurium to be only slightly attacked by potassium cyanide in boiling solution, and that the small proportion dissolved was not precipitated on addition of hydrochloric acid. He also proved that tellurium, although it goes into combination when fused with potassium cyanide, does so, not as telluro-cyanate, but as potassium telluride, and that this compound is entirely decomposed when dissolved in water, and exposed to the air. A little tellurium, not to be precipitated by air, was found by him to be also not precipitated by hydrochloric acid. The tellurium thus left in solution by either method of working was precipitable by sulphur dioxide, and was due to dissolution of oxidised tellurium, in the form of potassium salt, having taken place.

I have observed, however, that whether pure tellurium or tellurium mixed with selenium was boiled with potassium cyanide solution,* tellurium went into solution in a form not precipitable by air (telluride), not precipitable by hot potassium hydroxide and glucose solution (oxide), but precipitable by hydrochloric acid. This dissolved tellurium behaves, therefore, in a characteristic way, just like selenium in solution as seleno-cyanate, and would thus seem to be dissolved *telluro-cyanate*, a salt supposed hitherto not to exist at all.

This form of solution of tellurium, whatever view be adopted as to its nature, affects the separation of tellurium from selenium by the cyanide process. It has been considered tbat the precipitate formed by adding hydrochloric acid to the cyanide solution is selenium free from tellurium, and that the after-addition to the mother-liquor, of sulphur dioxide, which precipitates a little tellurium, yields all of that substance which has gone into solution —or, in the case of previous fusion, all that has resisted the action of a current of air. But I find, in accordance with what I have stated, that some tellurium in solution precipitates with the selenium, the rest coming down by treatment with sulphur dioxide.

By means of Stolba's reaction—reduction by an alkaline solution of glucose—the oxidised tellurium in solution can be first precipitated, and then the rest by hydrochloric acid. In this connection it must be remembered that Stolba's otherwise satisfactory method of precipitating tellurium is, in the presence of cyanide, not only inapplicable in the case of selenium, but also in that of tellurium.

When precipitated, or other finely-divided, tellurium is digested with concentrated solution of potassium cyanide in the cold, some of it still goes into solution, but in this case all as oxide—none in the state precipitable by hydrochloric acid. By such a digestion in the cold, selenium may be obtained free from tellurium when precipitated afterwards by hydrochloric acid, and may also be completely separated from tellurium by a sufficiently long digestion.

Preferential Precipitation by Sulphur Dioxide of Selenium before Tellurium. A striking Phenomenon capable of being applied to the Separation of these Bodies.

In a hydrochloric acid solution of oxidised tellurium and selenium, sulphur dioxide precipitates the tellurium so completely before the selenium, that, in consequence of the marked difference in colour of the two substances, a separation of them can be effected by this reagent in a very convenient way.

There should be a considerable quantity of hydrochloric acid present, because this promotes immediate precipitation, the solution should preferably be hot, and the sulphur dioxide, in the gaseous state, should be sent steadily into it. The coming out of the black tellurium is well marked and quite sudden. Through local excess of sulphur dioxide, tellurium may be seen to appear temporarily before all selenium has been liberated, but agitation then immediately re-dissolves the black tellurium by the substitution for it of an equivalent quantity of red selenium. With a little attention at the time when nearly all the selenium has been precipitated and tellurium becomes locally visible, the reducing action may be arrested at the right moment—that is, just before the blackening—and a separation of the two elements be easily made, which, though not accurate enough for analysis, yet enables the operator to obtain both pure selenium and tellurium, with only a very little mixed precipitate of the two in between.

I can recommend this method of separation as an excellent one for the purpose of preparing these substances in the pure state from a mixture of them.

Reversed order of Precipitation of Tellurium and Selenium in Acid and Alkaline Solutions. A Lecture Experiment.

Tellurium and selenium seem peculiarly well-fitted to illustrate the influence of the chemical function of allied elements upon the order of their reducibility to the simple state. For while the less basylous selenium comes out before tellurium from acid solutions, the less chlorous tellurium comes out before selenium in alkaline solutions.

I have in the preceding section called attention to the action of sulphurous acid upon hydrochloric acid solutions, and to the much greater oxidisability of tellurium by nitric acid, and will now add as a further example of the less basylous behaviour of selenium, the action of sulphuric acid upon them. Both substances, it is well known, dissolve in this acid, and impart characteristic colours to it—olive-green and purple-red. A solution of the two together is nearly black, as an effect of complementary absorption of light. Now, a mixed solution hot enough for oxidation to proceed in it, will suddenly lose its dark colour and become selenium-green, thus showing the prior oxidation of the tellurium. Again, when a little tellurium is added to a moderately warm solution of sufficient selenious hydroxide in sulphuric acid, it immediately dissolves, but the solution appears selenium-green coloured, instead of tellurium-red, thus showing the reduction by tellurium of oxidised selenium.

Turning now to alkaline solutions of tellurous and selenious hydroxides, we can observe the opposite order of reduction by means of Stolba's sugar reaction. On heating such a solution with glucose, black tellurium first

* The cyanide I used was from Hopkin and Williams, and was found to contain 65 per cent pure cyanide.

precipitates, and after a time red selenium makes its appearance.

These experiments are quickly performed, and are, besides, visible at a distance,—at least, that with sulphurous acid and that with sugar are thus to be seen. They are, therefore, well adapted for lecture illustration. Large volumes of solutions only require a few grains of the two substances to make a good display.

Sulphuric Acid as an Oxidising Agent for Selenium and Tellurium.

Sulphuric acid is decidedly preferable to nitric acid for oxidising selenium and tellurium for analytical purposes. It must be used concentrated, hot, and in somewhat large excess. The presence of so much acid is afterwards more advantageous than otherwise for the precipitation by sulphur dioxide. During the action it serves both to dissolve the tellurium and selenium before oxidation, and to keep much of the hydroxides in solution after the oxidation. The beaker in which the acid is heated should be kept covered to prevent fuming and retain the spray of the effervescence.

The superiority of sulphuric acid lies in the circumstances that oxidation being effected upon bodies in the state of solution, instead of in the solid state, goes on more rapidly and uniformly in consequence, and that it does not extend to the formation of any telluric or selenic acid, which would need reduction afterwards by boiling hydrochloric acid.

Caution needed in the Use of Bromine for Oxidising Selenium in Analytical Work.

If bromine in solution with hydrochloric acid be employed to dissolve selenium, it must be kept always in excess in the solution. For, when this is not done, selenium monochloride forms and volatilises from the aqueous solution along with hydrochloric acid, thus causing material loss and visible escape of selenium.

From this it would appear that hydrochloric acid gives stability to selenium monochloride in the presence of water. Most chemists will be aware that sulphur treated with an acid solution of bromine or chlorine evolves a strong odour of sulphur monochloride. I say chloride, not bromide, in these cases, because there can be no doubt that the bromide decomposes with hydrochloric acid.

Tellurium is not similarly affected by deficiency of bromine, and differs, as we all know, from sulphur and selenium in not forming a monochloride.

RESEARCHES ON THE TARTRATES OF ANTIMONY.

By F. W. CLARKE and CHARLES SETH EVANS.

Although some of the double tartrates of antimony, such as the tartar emetics, have been quite elaborately studied, our knowledge of its simple tartrates has hitherto been singularly inexact and vague. According to Bergmann,* a solution of antimonious oxide in aqueous tartaric acid crystallises confusedly; while according to Dulk* it does not crystallise at all. Berzelius† and Peligot‡ both obtained large crystals, but assigned different formulæ—Berzelius without analysis, Peligot after investigation. Peligot, however, must have calculated his formula upon the basis of Sb = 129, the old Berzelian determination; and his analysis, re-calculated with the modern value of Sb = 120, leads to no intelligible symbol. The precipitate formed by alcohol in solutions of the crystalline tartrate was also examined by Berzelius and by Peligot; and here, again, upon incomplete analyses, different formulæ were based. In short, neither Berzelius nor Peligot studied these compounds at all thoroughly; and the subject, up to the time when we began our own experiments, was in a most confused state. Inferences were more numerous than facts, and the latter needed scrupulous re-verification. We believe that we have succeeded in shedding some light upon the nature of the substances in question; and that the results which we have obtained may form a fair basis upon which to conduct future investigations.

Antimony trioxide, as is well known, is readily soluble in aqueous tartaric acid; but the properties of the solution depend upon the relative proportions of its constituents. When the oxide is dissolved in the acid to complete saturation, the solution yields no crystals whatever, but upon evaporation dries up to a gummy amorphous mass. With less oxide and an excess of acid crystallisation becomes possible, and in every case of this kind rosettes of needles are obtained. If the acid is in slight excess crystallisation takes place with difficulty, and the smaller the proportion of the oxide the more easily the crystals form. In all cases, however, in which the crystallisation occurs, the mother-liquors are exceedingly viscous, and consequently difficult to remove; so that it is by no means easy to secure pure products for examination. Furthermore, the crystals vary in composition, as the following percentages of antimony will show:—

1. 40 grms. of Sb_2O_3 were boiled with 60 grms. tartaric acid. The solution was incomplete. The filtered liquid, evaporated to dryness, gave a product containing 27·53 per cent of antimony.

2. 35 grms. Sb_2O_3 to 60 of acid. Yielded indistinct crystals which could not be purified for analysis.

3. 30 grms. Sb_2O_3 to 60 of acid. Crystals washed and twice re-crystallised. Per cent of Sb, 18 92.

4. 20 grms. Sb_2O_3 to 60 of acid. Product re-crystallised. Several distinct lots of material gave crystals containing antimony in the following percentages:—

A	13·35		
B	15·90		
C	16·48	16 64	
D	16·18	16·21	17·16
E	17·88	18·00	

The last product was dried with extreme care and examined further. The results will be given later.

5. 15 grms. Sb_2O_3 to 60 of acid. Product re-crystallised. Per cent of Sb, 5·37. Probably a mixture.

6. 12 grms. Sb_2O_3 to 60 of acid. Per cent of antimony in crystals, 3·69 to 3·82. Probably a mixture.

The antimony was weighed as sulphide in every case, and the results indicate two things—First, the difficulty of obtaining definite products; and, second, the probable existence of a series of salts. Two of the latter were analysed, as follows:—

First.—The crystals marked 3 and the preparation 4 E of the foregoing table had all the characteristics of definite compounds. They proved to be identical, and to be closely represented by the formula $Sb(C_4H_4O_6)_3H_3.4H_2O$.

	Found.				Calculated
	3.		4 E.		
Sb	18·92	17·88		18·00	18·78
C	22·59	22·98		23·19	22·53
H	3·78	3·39		3·78	3·60
Water at 120°	11·05		10·98		11·27

In brief, this tartrate, which may fairly be called antimonio-tritartaric acid, is simply a triple molecule of tartaric acid with half its replaceable hydrogen replaced by an atom of trivalent antimony. It crystallises in rosettes of white needles, and is easily soluble in water. With carbonates it effervesces strongly, and behaves like a weak acid. Its reactions in this particular will be considered further on. With alcohol its solution yields a copious white precipitate, which, washed with alcohol and thoroughly dried over sulphuric acid, proved to be neutral antimonious tartrate, $Sb_2(C_4H_4O_6)_3.6H_2O$.

* See "Gmelin's Handbook," edition of the Cavendish Society, x., 297.

† "Lehrbuch," 5 Aufl 3, 1124.

‡ *Annales de Chim. et de Phys.*, 3 série, xx., 289.

	Found.		Calculated.
Sb	30·58	30·76	30·30
C	18·14		18·18
H	3·01		3·03
Water at 160°	13·86		13·63

This salt is easily soluble in water. In its cold solution sodium carbonate produces no turbidity, but upon heating a copious white precipitate is thrown down. This particular precipitate we did not examine more closely, but its nature may be inferred from evidence to be cited later. It undoubtedly consists either of basic mixtures or of antimonious oxide, according to the amount of sodium carbonate used and the thoroughness of the boiling.

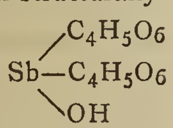
Attempts were made to prepare definite salts of antimonio-tritartaric acid, but unsuccessfully. Barium carbonate dissolves in a solution of the acid with brisk effervescence, but upon standing crystals of ordinary barium tartrate were deposited. The antimony in this case remained dissolved undoubtedly as the normal tritartrate. In another experiment a solution of the acid was rapidly neutralised with barium carbonate, and subsequently precipitated by alcohol. The copious white precipitate was washed with alcohol, air-dried, and partially analysed. So far as ascertained, its composition agrees with the formula $Sb_2(C_4H_4O_6)_3.4BaC_4H_4O_6.3H_2O$. It is probably a mixture.

	Found.		Calculated.
Sb	12·47		12·77
Ba	28·27	29·06	29·17
Water at 150°	2·45		2·87

Second.—It has already been stated that a saturated solution of antimonious oxide in tartaric acid does not crystallise. Such a solution (marked 1 in the previous table) was evaporated to dryness, and the dry product was analysed. The results were as follows:—

Sb	27·53
C	18·31
H	2·96
H_2O at 105°	10·92

This analysis is of dubious value. The compound may not have been definite, and the figures agree sharply with no probable formula. The antimony and carbon give a ratio corresponding to seven molecules of acid to four atoms of metal, and suggest the existence of a compound having the formula $Sb(OH)H_2(C_4H_4O_6)_2$. Such a formula, which may be written structurally—



is also indicated by Peligot's analysis of his "hyperacid tartrate," but it is not clearly proved. It is also further suggested by the following reaction:—

A solution containing the foregoing salt was mixed with alcohol. The usual white precipitate was washed with alcohol and air-dried over sulphuric acid. Its composition is clearly represented by the formula $Sb_2(C_4H_4O_6)_2O.6H_2O$.

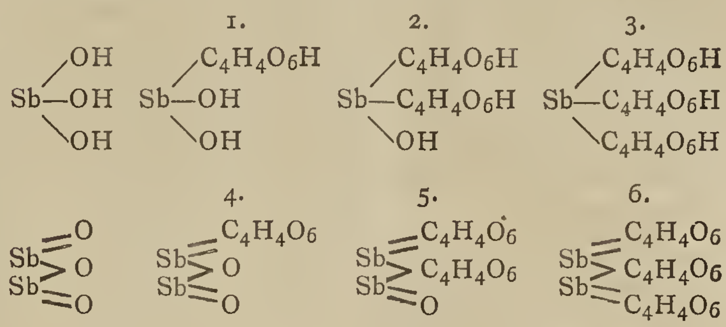
	Found.			Calculated.
Sb	36·88	36·22	36·58	36·37
C	13·56	13·90	13·56	14·54
H	2·65	2·72	2·47	3·03
H_2O at 155°	16·31	—	—	16·36

A portion of this was re-dissolved in water, and the solution was left to evaporate. No crystals formed, but the liquid dried up to a yellowish scaly mass, containing 16·39 per cent of water. Evidently no change in composition had occurred. Heated to 170° the salt lost another molecule of water, leaving two molecules of $Sb \equiv C_4H_3O_6$.

Actual loss at 170° 19·28 per cent. Theoretical, 19·09.

A similar precipitate was also examined by Peligot, who dried his product at 160° and estimated only carbon and hydrogen. From his results the formula $SbC_4H_3O_6$ has been inferred, as well as the existence of an acid salt $SbC_4H_5O_7$.* The latter compound, however, he never actually obtained; and the only evidence of its existence and properties was published from this laboratory some four years ago.†

If now we compare the formulæ of our two acid salts (using our hypothetical formula for the second) with those of the two alcoholic precipitates, certain obvious relations will appear. There ought plainly to be two series of antimony tartrates, one acid and one neutral; the first derived from ortho-antimonious acid, $Sb(OH)_3$, and the other from antimonious oxide, Sb_2O_3. The formulæ should be as follows, neglecting water of crystallisation:—



Of these, numbers 3, 5, and 6 we have actually obtained in definite condition, and number 2 we have shown to be probable. The latter is related to the neutral ditartrate just as antimonio-tritartaric acid is related to the tritartrate, and the name of antimonio-ditartaric acid may fitly be applied to it. By precipitation with alcohol it yields a neutral ditartrate, precisely as number 3 by a similar reaction yields number 6. The formula, doubled, and with five molecules of water added, is found in all reference works upon chemistry as that of Peligot's hyperacid tartrate.

The hypothetical compound numbered 1 in the foregoing schedule we did not obtain. Number 4, the monotartrate, we attempted to investigate, but with only partial success. After a number of failures, which resulted in the formation of the neutral ditartrate, we prepared a quantity of antimonious hydroxide, which we dissolved to saturation in aqueous tartaric acid. This solution yielded a precipitate with alcohol which was comparatively insoluble in water, and which, air-dried, had the subjoined composition:—

	Found.		Calculated for $Sb_2(C_4H_4O_6)O_2.2H_2O$.
Sb	53·62	53·84	52·63
C	6·43	5·38	10·52
H	1·65	1·51	1·75
H_2O at 160°	7·79		7·89

It will at once be seen that the analysis, though suggestive, is highly unsatisfactory. It merely emphasises the probability that the compound sought for exists. The white precipitate described by Berzelius had similar properties as regards insolubility, and his formula for it, translated into modern notation, agrees with ours. On the antimonyl hypothesis its formula is found in works of reference as $C_4H_4(SbO)_2O_6$. It needs, however, further investigation.

In all essential particulars the salt which we call antimonio-ditartaric acid behaves much like the corresponding tri-compound. It is strongly acid, effervesces with carbonates, and is not precipitated by alkalies in the cold. Its solution, saturated with barium carbonate and precipitated by alcohol, behaved precisely like that of the tri-acid, but the curdy white precipitate had a different composition. A partial analysis gave results agreeing with $Sb_2(C_4H_4O_6)_2O.3BaC_4H_4O_6.11H_2O$.

* Commonly written $C_4H_4H(SbO)O_6$.

† Clarke and Stallo *American Chemical Journal*, ii., 319.

	Found.		Calculated.
Sb	15·33		14·94
Ba	26·06	26·63	25·58
H_2O at 150°	12·66		12·32

This, too, is most probably a mixture, although both it and the corresponding tri-acid precipitate may be weak double compounds.

In order to get further evidence concerning the nature of the acid compounds, we neutralised a solution of the di-acid with sodium carbonate. The liquid, which remained perfectly clear, was then mixed with alcohol. At first it became turbid, and later it separated into two fluid layers, both clear, and both containing antimony. The lower layer was syrupy, and contained most of the sodium; it was accordingly drawn off, and evaporated at the ordinary temperature of the air over sulphuric acid. It slowly dried up to an amorphous gummy mass, which yielded a yellowish powder. This product we analysed. Although under the circumstances we could hardly expect a definite compound, our figures approximate to what is required by the empirical formula, $2Sb(OH)_3.3Na_2C_4H_4O_6.3H_2O$:—

	Found.		Calculated.
Sb	24·66	25·00	24·54
Na	13·48		14·11
C	15·64	15·77	14·72
H	2·62		2·45
H_2O at 150°	11·66		11·04

This compound is probably definite, although we may have failed to determine exactly the right formula. It is readily soluble in water, and very faintly acid towards litmus-paper. Its solution is stable even upon boiling, but is precipitated, when hot, by alkaline carbonates.

Another portion of the antimonio-ditartaric acid solution was exactly neutralised by sodium carbonate and boiled. A heavy precipitate fell, which we collected and dried over sulphuric acid. To the filtrate more sodium carbonate was added, and a second boiling threw down a second precipitate. Both precipitates 1 and 2 were analysed.

	I.		II.
Sb	47·87	47·28	84·25
C	3·96	4·24	—
H	3·44	3·21	—
H_2O at 155°	22·30		4·80

The second product is evidently antimonious oxide mixed with a little hydrate. The pure oxide contains 83·33 per cent of metal. The first precipitate approximates roughly to a tartrate having the formula—

$$Sb_4O_5(C_4H_4O_6).12H_2O,$$

analogous to the sulphate $Sb_4O_5(SO_4)$, the chloride $Sb_4O_5Cl_2$, &c. Doubtless such a tartrate exists, and might be prepared in a state of purity by proper precautions. It should contain 51·95 per cent Sb, 5·20 per cent C, 3·03 per cent H, 23·37 per cent H_2O. Our results, however, only indicate the probability of such a basic salt, formed by the partial precipitation of the higher tartrates, as a step in the reduction of the latter to oxide.

With the neutral* ditartrate of antimony one more suggestive experiment was tried. Its solution was cautiously mixed with dilute sulphuric acid to incipient turbidity, and then immediately precipitated by alcohol. The precipitate, which was white, contained sulphuric and tartaric acids, antimony, and water:—

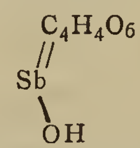
	Found.	
Sb	33·56	
SO_4	25·48	25·52
H_2O at 110°	12·31	

A compound having the formula—

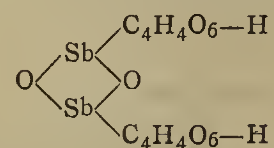
$$Sb_2(C_4H_4O_6)(SO_4)_2.7H_2O$$

would require 33·99 per cent Sb, 27·19 per cent SO_4, and 17·84 per cent H_2O. A loss of $5H_2O$ would amount to 12·75 per cent. Our figures, however, here, as in several other cases, are merely sufficient to establish a probability which may serve as a basis for future investigations. It may be regarded as practically certain that mixed salts of antimony are possible, and that sulphato-tartrates, &c., may be obtained by careful and systematic trial. Want of time precluded us from working farther in this direction.

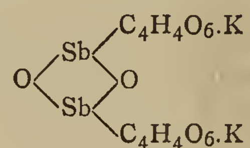
The foregoing results, taken altogether, establish certain points pretty clearly. First, contrary to Peligot's views, antimony forms perfectly normal tartrates, in which it acts like any other trivalent metal, and in which the assumption of an antimonyl radicle, SbO, is entirely inadmissible. The other tartrates of antimony fall naturally into series, in which we sometimes find the atoms Sb and O united in accordance with Peligot's hypothesis, but not in such a way as to give the latter any validity. In all such cases the SbO group is not to be regarded as a distinct radicle, but rather as an incident in a series; a mode of union found in many other basic compounds of other metals for which no special explanation has ever been thought necessary. In the tartar emetics we have a set of salts which may or may not be interpreted on the antimonyl theory, as was shown in this laboratory some years ago, but which are best explained by regarding them as derived from a complex tartrantimonious acid to which may be assigned either af the two formulæ given below:—

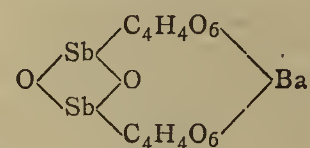


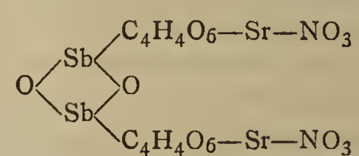
or



The first formula was adopted in the paper from this laboratory which we previously cited, but the latter is suggested by the fact that tartar emetic, as usually written, contains only half a molecule of water, and that therefore its formula should be doubled. On this plan the tartar emetics of barium and potassium may be formulated as below, and Kessler's double salt of strontium tartar emetic and strontium nitrate becomes easily explainable also.







In the course of our present investigation we have done some work upon this class of compounds, and notably as follows:—A quantity of silver tartar emetic was dissolved in boiling water and precipitated by the addition of amyl iodide. Silver iodide was thrown down, the solution was instantly filtered, and upon cooling white brilliant crystals were deposited. These were insoluble in water, and too small for us to determine their form. Analysis gave a composition best represented by the empirical formula $2Sb_2(C_4H_4O_6)O_2.Ag_2C_4H_4O_6.3H_2O$.

	Found.		Calculated.
Sb	37·37	38·54	38·15
Ag	17·19		17·17
C	11·21	11·26	11·45
H	1·15	1·21	1·42
H_2O at 150°	3·43		4·29

Although the agreement here is very close, and the preparation of the salt, repeated several times, gave a perfectly uniform and apparently definite product, the formula cannot be regarded as certain. Our difficulty is that a

* The word "neutral" is inexact, but serves provisionally to indicate those tartrates of antimony which contain no replaceable hydrogen. Some of them are really basic.

similar experiment with ethyl iodide gave a salt of similar appearance but of different composition, as follows:—

Sb	33·37
Ag	21·61
C	11·86
H	1·16
H_2O	4·44

Possibly this preparation, which we made only once, contained unaltered silver tartar emetic. At all events, uncertainty exists, and further investigation is necessary. If the formula given above should prove to be correct it would relate the compound structurally to the salts

$$Sb_4O_5Cl_2,\ Sb_4O_5(SO_4),\ \&c.$$

In conclusion, we may describe the following new tartrantimonites:—

Aniline tartrantimonite, $SbC_4H_5O_7.C_6H_7N$, was obtained by treating the barium salt with a solution of aniline sulphate. It crystallises very easily in long white prisms, sometimes discoloured by traces of oxidation products, and has a specific gravity of 1·890 at 11°. It yielded 31·74 per cent of antimony, which is exactly the theoretical amount.

The quinine and atropine tartar emetics were prepared in a similar manner by Mr. Karl W. Langenbeck. Both salts were amorphous, yellowish, translucent masses. The quinine salt was anhydrous; the atropine salt contained two molecules of water. The analytical data are subjoined:—

Quinine Salt.	Found.		Calculated.
Sb	19·63	19·76	19·70

Atropine Salt.	Found.	Calculated.
Sb	19·88	19·67
H_2O	5·62	5·90

—*American Chemical Journal*, Vol. v., No. 4.

ON THE DETERMINATION OF THE NUMBER OF ATOMS IN MOLECULES.

By C. A. SEYLER.

The number of substances whose molecules can be determined by vapour densities is limited, and the method I have to offer may prove useful, as it is applicable to many cases of bodies which can be readily fused. In order to make it intelligible a few words on "Density" and "Specific Gravity" are necessary. The terms are often used as synonymous, but it is of importance to differentiate them. Specific gravity is the total effect of three things, molecular weight, density or intermolecular distance, and structure. Increase of molecular weight of course increases specific gravity; decrease of intermolecular distance or increase of density produces greater specific gravity, while structure decreases it. The effect of crystalline structure is often so great as to overbalance the effect of increase of density in the opposite direction. Thus the expansion of water at temperatures below 4° C. is due to the commencement of that crystalline structure which culminates in ice; and that increase of density goes on simultaneously with the expansion is supported by the observation of Arago and Fresnel that its refractive power on light continues to increase regularly as though it were growing denser (as I maintain it does).

Now from theoretical reasons I concluded in Jan., 1883, that latent heat of fusion is proportionate to the difference of density (as I define it) of the bodies in the solid and liquid states. The simplest way of calculating the density is to divide the "relative weight" (referred to hydrogen) by the molecular weight of the body. The same result may be had on a basis of Avogadro's law, but it is not necessary to state it here. If the molecular weight be unknown, the atomic weight must be used and the result indicates the density of the body *if its molecule consist only of one atom*. From data of Erman (*Ann. de Chim. et de Phys.*, xl., 209) who found the specific gravity of phosphorus just before melting to be 1·8121, and just after 1·756, I have calculated the density thus:—

P just before fusion	652·3.
P just after fusion	632·1.

The difference of these numbers is 20·2, which, *assuming the molecule of P to contain only one atom*, should (according to my theory) be the latent heat of fusion. But we know that the molecule of P contains 4 atoms, and dividing the densities by 4 we get—

163·075
158·025

The difference of these numbers is 5·05, while the latent heat of fusion is 5·034 according to Person. From data of Cavendish (*Phil. Trans.*, 1783, p. 23) and Mallet, who makes the specific gravity of mercury at its fusing-point, 14·193, I have calculated the following numbers:—

Hg just before fusion..	792·2
Hg just after fusion	789·5

The difference is 2·7, while the latent heat, according to Person, is 2·8. As the theoretical number is calculated for a monatomic molecule we should expect the mercury molecule to contain only one atom, as we know to be the case. I may state my method then thus:—

The difference between the real density of a body just before and after fusion divided by the experimental latent heat gives the number of atoms in the molecule.

The density determinations are of course only useful where the body is comparatively structureless and *consequently* contracts on solidifying, but such bodies are, I believe, the rule. In crystalline bodies the density determinations will be too low, but in cases like mercury and phosphorus, where there is little crystalline structure, my rule gives closely corresponding results. If Person be right in his rule that latent heat of fusion equals the difference of absolute heat (weight × specific heat × temperature) in the solid and liquid state, then a remarkable conclusion may be drawn from my generalisation, viz., real density of a body is proportionate to its absolute temperature.

Another theory was that the density of liquids at their boiling-points should be proportionate to the latent heat of condensation. This, if true, may also help to determine the molecule of compound bodies, but I have been unable to put it properly to the test. In the following determinations the number for water is calculated from Hällström's data (*Pogg. Ann.* I., 129); the rest from rough experiments of my own:—

	Density at b.-p.	Lat. Heat.	
Water	530	535	
Oil of turpentine	71	74	
Methyl alcohol.	271	263	both impure
Ethyl alcohol .	186	202	both impure

I should be glad of any determinations of the specific gravities of bodies either before or after fusion, or of liquids at their boiling-points.

Spurious Tartar Emetic.—M. Castelhaz has in a recent circular called the attention of consumers to the sophisticated, or rather spurious, samples of antimony-potassium tartrate now in the market. This compound is used on the large scale for fastening certain coal-tar colours upon cotton, and being of course costly the attempt has been made to employ the corresponding oxalate as a substitute. The effects of this new salt both upon the fibre and upon the colours are not in all cases satisfactory, and its admixture with, or clandestine substitution for, the double tartrate is certainly a fraud. For its detection the following simple test is proposed:—A portion of the sample is dissolved in distilled water, acidified with pure acetic acid, and a solution of calcium chloride is added. If an oxalate is present a white precipitate is formed, whilst in case of a genuine double tartrate the solution remains clear.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

MERCURY.

In dealing with the atomic weight of mercury we may reject the early determinations by Sefström† and a large part of the work done by Turner.‡ The latter chemist, in addition to the data which will be cited below, gives figures to represent the percentage composition of both the chlorides of mercury; but these results are neither reliable nor in proper shape to be used.

First in order we may consider the percentage composition of mercuric oxide, as established by Turner and by Erdmann and Marchand. In both investigations the oxide was decomposed by heat, and the mercury was accurately weighed. Gold leaf served to collect the last traces of mercurial vapour.

Turner gives four estimations.‖ Two represent oxide obtained by the ignition of the nitrate, and two are from commercial oxide. In the first two the oxide still contained traces of nitrate, but harly in weighable proportions. A comparison of the figures from this source with the others is sufficiently conclusive on this point. The third column represents the percentage of mercury in HgO.

144·805 grains Hg =	11·54 grains O.	92·619 per cent.
125·980 ,,	10·08 ,,	92·592
173·561 ,,	13·82 ,,	92·625
114·294 ,,	9·101 ,,	92·620

Mean 92·614 ± 0·0050

In the experiments of Erdmann and Marchand§ every precaution was taken to ensure accuracy. Their weighings, reduced to a vacuum standard, give the subjoined percentages:—

82·0079 grm. HgO gave	75·9347 Hg.	92·594 per cent.
51·0320 ,,	47·2538 ,,	92·597
84·4996 ,,	78·2501 ,,	92·604
44·6283 ,,	41·3285 ,,	92·606
118·4066 ,,	109·6408 ,,	92·597

Mean 92·5996 ± 0·0015

Combining, we have:—

Turner	92·614	± 0·0050
Erdmann and Marchand ..	92·5996	0·0015
General mean	92·601	0·0014

With a view to establishing the atomic weight of sulphur Erdmann and Marchand also made a series of analyses of pure mercuric sulphide. These data are now best available for discussion under mercury, The sulphide was mixed with pure copper and ignited; mercury distilling over and copper sulphide remaining behind. Gold leaf was used to retain traces of mercurial vapour, and the weighings were reduced to vacuum:—

34·3568 grm. HgS gave	29·6207 Hg.	86·215 per cent Hg.
24·8278 ,,	21·40295 ,,	86·206
37·2177 ,,	32·08416 ,,	86·207
80·7641 ,,	62·6372 ,,	86·223

Mean 86·2127 ± 0·0027

For the percentage of mercury in mercuric chloride we have data by Turner, Millon, and Svanberg. Turner,¶ in addition to some precipitations of mercuric chloride by silver nitrate, gives two experiments in which the compound was decomposed by pure stannous chloride, and the mercury thus set free was collected and weighed. The results were as follows:—

44·782 grains Hg =	15·90 grains Cl.	73·798 per cent.
73·09 ,,	25·97 ,,	73·784

Mean 73·791 ± 0·005

Millon* purified mercuric chloride by solution in ether and sublimation, and then subjected it to distillation with lime. The mercury was collected as in Erdmann and Marchand's experiments. Percentages of metal as follows:—

73·87
73·81
73·83
73·87

Mean 73·845 ± 0·010

Svanberg,† following the general method of Erdmann and Marchand, made three distillations of mercuric chloride with lime, and got the following results:—

12·048 grms. $HgCl_2$ gave	8·889 Hg.	73·780 per cent.
12·529 ,,	9·2456 ,,	73·794
12·6491 ,,	9·3363 ,,	73·810

Mean 73·795 ± 0·006

Combining these series we have:—

Turner	73·791	± 0·005
Millon	73·845	0·010
Svanberg	73·795	0·006
General mean	73·798	0·0034

In this mean Turner's figures undoubtedly receive undue weight, for, on experimental grounds, they are probably inferior to both of the other series. It is better, however, that the general mean should remain as it is than that I should deal arbitrarily with any of the data.

We now have three figures to calculate from:—

Per cent of Hg in HgO ..	92·601	± 0·0014
,, HgS ..	86·2127	0·0027
,, $HgCl_2$ ..	73·798	0·0034

These give us three values for the atomic weight of mercury and a general mean as follows:—

From HgO .. .. Hg =	199·786	± 0·059
From HgS .. .. ,,	200·016	0·088
From $HgCl_2$ .. .. ,,	199·239	0·086
General mean .. ,,	199·712	0·042

If O = 16, then this becomes 200·171.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† Sefström. Berzelius's Lehrb., 5th Ed., 3, 1215. Work done in 1812.
‡ *Phil. Trans.*, 1833, 531—535.
‖ *Ibid.*, 1833, 531—535.
§ *Journ. f. Prakt. Chem.*, 31, 395; 1844.
¶ *Phil. Trans.*, 1833, 531—535.

* *Ann. Chim. Phys.*, (3,) 18, 345. 1846.
† *Journ. f. Prakt. Chem.*, 45, 472. 1848.

ON THE USE OF LITMUS, ROSOLIC ACID, METHYL ORANGE, PHENACETOLIN, AND PHENOLPHTHALEIN AS INDICATORS.‡

Part II.

By ROBERT T. THOMSON.

The first part of this paper was confined exclusively to the use of these indicators in the analysis of some of the more important compounds of potassium, sodium, and ammonium, and to the determination of free acids by hydrate of sodium. Since then I have devoted some at-

‡ Read before the Chemical Section of the Glasgow Philosophical Society, December 10th, 1883.

tention to their behaviour with a few compounds of calcium, barium, and magnesium, and other substances. In this portion of the subject I have been forestalled to some extent by other chemists, who have published results which will be referred to, as they present themselves for consideration in the following paper.

I. *Application of the Indicators to the Determination of Lime existing as Hydrate, with a small proportion of Carbonate.*

For each experiment 200 c.c. of lime-water were employed, and to this was added 0·0265 grm. of carbonate of sodium, which precipitated an equivalent proportion of carbonate of calcium. This was done in a *cold* solution. The total lime (CaO) present was 0·2724, and that existing as carbonate 0·014 grm. The estimation was accomplished by half-normal hydrochloric acid, and from the result was deducted the number of c.c. required to neutralise the hydrate of sodium produced by the action of the carbonate of sodium added.

Litmus.—When this indicator was employed the test acid was added in the cold (this being the course pursued in each case) until the blue colour became purple. The solution was then boiled, and the addition of acid continued until the blue colour gave place to red, the end-reaction being very distinct. 19·4 c.c. were consumed in one experiment, and 19·5 in another, results which closely agree with the total amount of lime present. It is needless to give the results more minutely at this stage, as they will be arranged in a short table at the end of this section, along with those obtained with the other indicators.

Rosolic Acid.—The remarks made concerning litmus apply with equal weight to rosolic acid, except in the matter of colour; the latter indicator changing from deep pink to yellow. 19·4 c.c. of the acid were required in each case.

Methyl Orange.—With this indicator practically the whole of the lime was determined in the cold, no boiling being necessary, owing to the fact that the liberated carbonic acid has no effect on the colour. The results were precisely the same as those obtained with rosolic acid.

Phenacetolin.—The value of phenacetolin for the purpose under examination has been accurately estimated by Prof. Lunge, and it is therefore only for completeness sake that it is here dealt with. The method is similar to that fully described in the first part of this paper for the estimation of hydrate in presence of a little carbonate of sodium. The hydrate of calcium is first determined by adding the standard acid until the scarcely perceptible yellow colour is transformed to a distinct permanent pink, and then the proportion of carbonate of calcium is obtained by further addition of acid until the pink gives place to a deep yellow colour. For the two tests 18·4 and 18·3 c.c. were required respectively to neutralise the hydrate, while an additional 1·1 c.c. was necessary to decompose the carbonate of calcium.

It may not be out of place to remark here that my experience with phenacetolin leads me to the conclusion that it requires more skill in manipulation, when used for the determination of hydrate of potassium, sodium, or calcium, than is altogether desirable. The operator has not to deal with a sharp and unmistakable end-reaction, but is left to a certain extent in a state of indecision as to the exact point at which the pink colour, due to the action of the carbonate after neutralisation of the hydrate, shows itself. With experience, however, I have no doubt that good and concordant results are obtainable. Of course these remarks do not apply to the determination of soda or lime in the state of carbonate.

Phenolphthalein.—As was to be expected, this indicator, under favourable circumstances, behaved in the same way as in the parallel determination of the respective proportions of hydrate and carbonate of sodium. The test acid was added as carefully as possible, especially after nearly all the hydrate of calcium was neutralised, to prevent loss of carbonic acid, and when 18·9 in one experiment and 18·85 c.c. in another had been added, the red colour which had been diminishing in intensity was entirely discharged. At the same time the carbonate of calcium had passed into solution, a faint turbidity which remained being being no doubt due to the phenolphthalein. The results show that the whole of the lime existing as hydrate and half of that existing as carbonate had been estimated, thus proving that bicarbonate of calcium is neutral to phenolphthalein, just as the bicarbonates of potassium and sodium are. The solution was now boiled for a considerable time, but the red colour did not reappear, although normal carbonate of calcium was precipitated, the bicarbonate being decomposed and carbonic acid expelled. On adding excess of acid, boiling, and titrating back with caustic alkali, the whole of the lime was obtained. To verify these results, and account for the apparently anomalous behaviour of carbonate of calcium towards phenolphthalein, 0·2 grm. of the former compound freshly precipitated from a cold solution (hydrate being absent), was treated with the half-normal acid. After 4·1 c.c. had been added all the carbonate of calcium was found to be dissolved, and the red colour had disappeared. The result is equal to 0·1025 grm. of carbonate of calcium, or almost exactly half the quantity used, and this agrees with the results quoted above. On boiling, the calcium carbonate was precipitated as a hard crust on the beaker, but the colour did not return, and it now remains to enquire why this is so. Another test showed that although carbonate of calcium recently precipitated from a cold solution gives an alkaline reaction with phenolphthalein, if it is boiled no colouration is produced. At the same time the carbonate of calcium is converted from a light flocculent condition into a dense granular form, and it seems that only in the former state can the indicator penetrate into it and develop the red colour. A portion of this dense form of the compound was collected, dried, and ground finely in the agate mortar, but even then only a faint red tint was produced, which disappeared on simple boiling, or on addition of a mere trace of acid. From these facts the conclusion can be

TABLE I.

Showing results obtained with each indicator when used in the determination of lime as hydrate with a small proportion of carbonate of calcium.

Lime, existing as hydrate, employed	.. ..	0·2584
,, ,, carbonate, ,,	.. ..	0·0140
Total lime employed	.. ..	0·2724

Indicator.	Grm. of total CaO found.	Grm. of CaO as Hydrate found.	Grm. of CaO as Carbonate found.
Litmus—	0·2716—0·2730	— —	— —
Rosolic acid—	0·2716—0·2716	— —	— —
Methyl orange—	0·2716—0·2716	— —	— —
Phenacetolin—	0·2730—0·2716	0·2562—0·2576	0·0154—0·0154
Phenolphthalein—	0·2716—0·2716	0·2590—0·2576	0·0140—0·0154

TABLE II.

Showing proportions of lime existing as hydrate and carbonate, respectively, in a sample of slaked lime (1) by alkalimetric method, using phenolphthalein as indicator, and (2) by the ordinary gravimetric method for determination of lime and carbonic acid.

By Alkalimetric Method.		By Gravimetric Deter- of Lime and CO_2.	
Grm. CaO as Hydrate found.	Grm. CaO as Carbonate found.	Grm. CaO as Hydrate found.	Grm. CaO as Carbonate found.
0·5656	0·1134	0·5660	0·1130
0·5670	0·1141	0·5665	0·1128

safely drawn that hydrate can be determined in presence of carbonate of calcium by simply adding hydrochloric acid to a boiling solution till the red colour is gone. The lime existing as hydrate will thus be estimated, while that existing as carbonate will be left untouched.

To apply this process, a sample of slaked lime which had become carbonated to a considerable extent, and in which the total lime and carbonic acid were estimated in the ordinary way, was treated as above described. To 1 grm. of the sample a quantity of boiling water was added, the mixture boiled for a few seconds, and then titrated with half-normal acid, all the hydrate of calcium being brought into solution by agitating well after each addition. In two experiments 40·4 and 40·5 c.c. were consumed respectively, which give as an average 0·5663 grm. of lime (CaO) existing as hydrate, while the amount obtained by estimating the total lime by the ordinary gravimetric method, and subtracting that existing as carbonate, was 0·5660 grm. The carbonate of calcium was then determined by adding excess of standard acid, boiling, and titrating back with caustic soda. For this part of the process 8·1 and 8·15 c.c., respectively, of the half-normal acid were consumed, giving as an average 0·1137 grm. of lime existing as carbonate, while that calculated from the carbonic acid estimation was 0·1130 grm. Taking into consideration these results, and also those quoted above, it is not too much to say that the complete neutrality of carbonate of calcium to phenolphthalein, under the circumstances described, may be depended upon without the least hesitation.

II. *Determination of Lime existing as Carbonate.*

As the principal points in connection with this portion of the subject have already been alluded to, it will only be necessary to make one or two supplementary remarks. Litmus, rosolic acid, phenacetolin, and methyl orange can all be used with advantage for this estimation, especially when the carbonate of calcium is in the light flocculent condition. The first three of these indicators are not by any means so delicate when that compound is in a more dense form. The behaviour of phenolphthalein has already been fully discussed.

III. *Determination of Hydrate and Carbonate of Barium.*

All that has been noted with regard to litmus, rosolic acid, and methyl orange, for the determination of lime, applies with equal force to that of baryta.

Phenacetolin can be employed for the estimation of the respective proportions of baryta existing as hydrate and carbonate.

Phenolphthalein acts in the same way as it does with the calcium compounds, and may be used to find the quantity of hydrate of barium, in presence of the carbonate, the latter remaining neutral. It is noteworthy, however, that carbonate of barium, even when freshly precipitated from a cold solution, does not develop a red colour with phenolphthalein, but remains neutral. If a little colour is produced it is permanently dispelled by a mere trace of acid, or even by simple boiling.

IV. *Determination of Hydrate and Carbonate of Magnesium.*

The total magnesia existing as hydrate and carbonate can be determined by adding excess of standard sulphuric acid, boiling to dissolve perfectly and expel carbonic acid, and then titrating back with alkali. For this purpose any of the indicators may be employed. Magnesia in solution as bicarbonate can be determined directly by standard acid, in the cold with methyl orange, or in the boiling solution with any of the other indicators.

The estimation of hydrate in presence of carbonate of magnesium, using phenacetolin or phenolphthalein as indicator, is almost impossible, as the hydrate is so insoluble in water, and the limited supply of acid which requires to be added attacks it so slowly that the results are eminently unsatisfactory.

Before passing on to other compounds special attention ought to be drawn to the method recently proposed by Hehner (*Analyst*, vol. viii., page 77), for the "Estimation of Hardness without Soap Solution." By this process, which should certainly supersede the less accurate soap test for the hardness of waters, the hardness due to the carbonates of calcium and magnesium is first determined directly by standard acid in one portion of the sample. The titration must be done in a hot solution if phenacetolin, cochineal, or rosolic acid is employed as indicator, or in the cold if methyl orange is used. The author of the process recommends phenacetolin as the most delicate, and this is undoubtly the case. Having thus determined the temporary hardness, to another portion of the sample a measured quantity of standard carbonate of sodium, which must be in considerable excess, is added, and the mixture boiled till all the calcium and magnesium salts are converted into carbonate. The precipitate produced is filtered off, and the excess of carbonate of sodium determined in the filtrate by standard acid. The difference between this result and the total quantity of carbonate of sodium added is calculated to carbonate of calcium, the answer being, when brought to grains per gallon, the degrees of hardness due to salts of calcium and magnesium other than carbonate. It would be out of place to add anything to the convincing series of experiments published by Hehner, further than to state that, as the result of experiment on samples of water, I have found that the degress of hardness obtained by this simple process agree very closely with those secured by calculation from the proportions of the various compounds of calcium and magnesium determined by the ordinary gravimetric methods. One point, seldom or never referred to, is the presence of carbonate of sodium, which is not unfrequently met with in waters. When this compound is present it is obvious that the determination of temporary hardness will be high, and that in estimating the permanent hardness the amount of carbonate of sodium obtained will be greater than the quantity added. This increase calculated to carbonate of calcium, and deducted from the result at first recorded as temporary hardness, will give the true temporary hardness. And this will also represent the total hardness, as a water containing carbonate of sodium cannot contain salts of calcium or magnesium other than carbonate.

V. *Chloride, Nitrate, and Sulphate of Calcium, Barium, and Magnesium.*

These salts are neutral to all the indicators, and only in the case of methyl orange somewhat more standard acid is required to produce the full change in colour when the end reaction is reached than is necessary in solutions free from these salts. This is also true, as I had occasion to point out before, with regard to the neutral salts of potassium, sodium, and ammonium.

It has been established above that carbonate of calcium, when precipitated from a solution and boiled, is neutral to phenolphthalein. This is so decidedly the case that the amount of calcium can be determined in any neutral compound of that metal by titration with carbonate of sodium. The method of procedure is to add phenolphthalein to the solution, then neutralise with hydrate of sodium if acid, and finally add standard carbonate of sodium till the red colour at first developed is no longer discharged on boiling for a few minutes, but remains permanent. Two experiments made respectively with chloride and nitrate of calcium (each solution containing 0·096 grm. of calcium) consumed 9·6 and 9·65 c.c. of half-normal carbonate of sodium, the results being almost exactly the same as the amount of lime really present.

Similar results were obtained with barium chloride, but with magnesium salts a red colouration is produced immediately on addition of a little carbonate of sodium, and is not dispelled by prolonged boiling. The above process, therefore, cannot be used for the estimation of calcium in presence of magnesium salts, as these seem to be decom-

posed simultaneously with the calcium compounds, and produce a colouration at once.

VI. *Sulphites of Calcium and Magnesium.*

For each experiment 0·525 grm. of normal sulphite of calcium was employed, and this was prepared by mixing a quantity of solution of sulphurous acid containing 0·28 grm. of SO_2; with hydrate of calcium solution solution containing 0·245 grm. of CaO.

Litmus.—With this indicator the change in colour was very gradual, so that anything like a desirable degree of certainty could not be attained to As about 8·5 c.c. of the half-normal hydrochloric acid were consumed it is evident that the bisulphite of calcium may be roughly regarded as the salt neutral to litmus, while the normal sulphite is strongly alkaline.

Rosolic Acid, unlike litmus, gives a sharp and well-defined end-reaction, the results of two experiments being that only a mere trace of acid was required to discharge the pink colour in a cold solution, while in a boiling solution 0·4 and 0·5 c.c. were respectively consumed. These results clearly show that normal sulphite of calcium is practically neutral to rosolic acid in a cold solution, although it shows a considerable alkaline reaction when boiling.

Methyl Orange agrees with rosolic acid in giving a delicate end-reaction, but here all likeness ceases. For the two tests 8·7 and 8·75 c.c. of half-normal acid were respectively required, which give as an average 0·1221 grm. of lime, or almost exactly half the amount really present. The bisulphite of calcium is thus neutral to methyl orange.

Phenacetolin acts in every respect like litmus, giving an exceedingly indefinite end-reaction, to bring out which about 8·5 c.c. of the standard acid was consumed.

Phenolphthalein.—The normal sulphite of calcium is neutral to this indicator, both in a cold and a boiling solution, probably being so in the latter because the sulphite of calcium is all, or nearly all, precipitated, and cannot attack the phenolphthalein.

Table III.

Showing results obtained in the titration of calcium sulphite with half-normal hydrochloric acid.

Amount of $CaSO_3$ employed for each test, 0·525 grm.
Equal to CaO ,, ,, 0·242 ,,

Name of Indicator.	C.c. half round acid consumed.	Grms. CaO obtained.
Litmus	8·5	0·1190
Rosolic acid (cold)	—	trace
,, (boiling)	0·4—0·5	0·0056—0·0070
Methyl orange ..	8·7—8·75	0·1218—0·1225
Phenacetolin	8·5	0·1190
Phenolphthalein (cold)	—	trace
,, (boiling)	—	—

As regards magnesium sulphite it is only necessary to remark that it acts in exactly the same way towards these indicators as calcium sulphite. A description of the experiments would be merely a repetition of what has been already related concerning the latter compound.

Leaving out of sight the results obtained with litmus and phenacetolin (these indicators being absolutely useless for all purposes connected with the accurate testing of sulphites) and looking more closely at those brought out when rosolic acid, methyl orange, and phenolphthalein were employed, it is plainly evident that a method might be constructed for the determination of sulphurous acid in a solution of that compound, or of bisulphite of lime. Such a process would obviously be based on the difference of indication shown by methyl orange on the one hand, and rosolic acid or phenolphthalein on the other, the bisulphite of calcium ($CaH_2(SO_3)_2$) being neutral to the first-mentioned indicator, while the remaining two indicate the normal sulphite ($CaSO_3$) as the neutral salt. The analogous behaviour of these three indicators with the sulphites of sodium and potassium was pointed out in the first part of this paper. To perform the titration, measure out a portion of the sample (from 20 to 50 c.c. will be convenient quantities), add methyl orange, then solution of caustic soda if acid, or hydrochloric acid if alkaline, from a burette till the neutral point is reached. Now add rosolic acid or phenolphthalein, and then normal or half-normal hydrate of sodium till the characteristic pink or red colour is just apparent. Multiply the number of c.c. consumed during the second stage of the process by 0·064 if normal alkali is used, and the answer will be the number of grms. of SO_2 in the quantity of sample operated upon. The following were results obtained in testing equal volumes of a sample of bisulphite of lime both by this and the volumetric iodine method.

Table IV.

Showing results obtained in testing bisulphite of lime by the alkalimetric and volumetric iodine methods respectively.

Name of Indicator.	Alkalimetric Method. C.c. of N/2 NaHO consumed.	Grm. of SO_2 found.	Iodine Method. Grm. of SO_2 found.
Rosolic acid ..	14·4	0·4608	0·4590
Phenolphthalein	14·4	0·4608	0·4570

It is obvious, from the nature of the process, that sulphuric or hydrochloric acid cannot have any effect on the accuracy of the above process, as they give rise to salts neutral to rosolic acid, methyl orange, and phenolphthalein during the first addition of caustic soda. The presence of phosphoric acid, however, would be very injurious, as it would be partly counted as sulphurous acid. The only other substance likely to vitiate the results so far as to make them useless is carbonic acid, which, as has been abundantly proved, has a very great effect on rosolic acid and phenolphthalein, but more especially on the latter. The solution in this case cannot be boiled as it can in the similiar determination of phosphoric acid in phosphate of soda, after bringing it to the neutral point with methyl orange as indicator. It is therefore necessary to use a standard soda solution free from carbonate of sodium. To obtain this make up a solution of caustic soda, and determine in it the sulphate and carbonate of sodium, the former by precipitation as barium sulphate, the latter by titration with acid, using phenacetolin or phenolphthalein as indicator. Now knowing the proportion of these impurities it is only necessary to take a measured quantity of the solution of hydrate of sodium, add a quantity of chloride of barium equivalent to the carbonate and sulphate of sodium present, allow the precipitate to settle, and syphon off the clear liquor, which is then only to be tested and reduced to the required standard.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 9, November 20, 1883.

Researches on the Hyponitrites.—MM. Berthelot and Ogier.—A thermo-chemical paper which does not admit of useful abstraction.

Formation-heat of Chromic Acid.—M. Berthelot.

Researches on the Chromates.—M. Berthelot.—Chromic acid approximates to the class of acids easily separable from water like the sulphurous and carbonic, and not forming stable definite hydrates. Acetic and even

carbonic acid convert the neutral chromates into bichromates.

Alkaline Hyposulphites.—M. Berthelot.—Thermochemical papers, not capable of abridgment.

Pyrogenous Decomposition of Potassium Sulphite.—M. Berthelot.—The decomposition of this salt does not take place at 450°; it remains unaltered until raised to dull redness, and even at that temperature requires some time for complete decomposition.

Researches on Alkaline Sulphites.—M. Berthelot.—The alleged anhydrous potassium bisulphite of Muspratt, Rammelsberg, and De Marignac, instead of belonging to the same type as the other sulphites, belongs to a distinct type, the *meta-sulphites*, as different from the sulphites properly so-called as are the meta-phosphates and the pyro-phosphates from the normal phosphates.

Meta-sulphites.—M. Berthelot.—The author carries out the subject of the foregoing memoir chiefly from a thermo-chemical point of view.

Nitrogen Selenide.—MM. Berthelot and Vieille.—The explosion-heat of this dangerous substance = +42·3.

Presence of Manganese in the Zinc of Commerce, and the Means of Detecting its Traces in Zinc Ash and Calamine. Detection of Bismuth in Lead.—A. Guyard.—The zinc of commerce contains normally manganese. In zinc ash, iron, copper, and the majority of the non-volatile metals accumulate. For the detection of manganese the author dissolves zinc ash in sulphuric acid, and submits this solution to electrolysis. In a few seconds the positive pole, which should be a slip of sheet-platinum. is seen surrounded by a halo of violet permanganic acid. In like manner a small quantity of sulphuric acid is saturated with calamine, and the liquid is submitted to electrolysis even without filtration, when in a few seconds permanganic acid appears at the positive pole. The negative pole during these experiments becomes brilliantly coated with metallic zinc. When we employ as positive electrode a slip of lead, the formation of permanganic acid is easily observed, and the lead is covered with a thick coating of lead peroxide. Any bismuth which it may contain is dissolved, and is transferred to the negative electrode, where it is precipitated along with the zinc. To determine with certainty the presence of bismuth in lead, it is laminated, and used as a positive electrode in a solution of chemically pure zinc sulphate. Then the zinc deposited at the negative pole is re-dissolved in weak sulphuric acid. The blackish residue consists of bismuth and copper derived from the lead. In this state they are easily recognised chemically.

The Use of Boric Acid and Hæmatoxyline in Alkalimetry.—A. Guyard.—Already noticed.

Preparation of the Nitro-molybdic Reagent at the Maximum of Concentration.—A. Guyard.—Already noticed.

Reclamation of MM. Camille Vincent and Delachanal concerning a Process for obtaining the Sulphocarbonates, published by M. Sestini.—The authors patented, on March 3, 1881, the same process which M. Sestini describes as novel in the *Bulletin de la Société Chimique*, October 5, 1883.

No. 10, December 5, 1883.

Formation of the Double Salt in Anderson's Reaction.—Œchsner de Coninck.—The author refers to a former paper read before the *Société Chimique*, and comments on the difficulty of obtaining the salt in a state of purity.

Cosmos les Mondes.
No. 13, November 24, 1883.

Dyeing Feathers.—A short paragraph giving no novel information.

The Electro-deposition of Nickel.—H. Fontaine.—For the baths M. Gaiffe gives the following formula:—

Nickel and ammonium, double sulphate ..	1 kilo.
Distilled water	10 litres.

M. Roseleur prefers to take:—

Double sulphate	400 grms.
Ammonium carbonate	300 ,,
Distilled water	10 litres.

Each of the two salts is dissolved separately in a part of the water. The solution of ammonium carbonate is gradually poured into that of nickel, taking care not to pass the point of neutrality. The quantity of 300 grms. of ammonium carbonate indicated above is not obligatory, but may be varied according to the quality of the salt of nickel. M. Adams proposes the two following mixtures:—1. Chloride.—Take 135 grms. pure nickel, and dissolve in hydrochloric acid, avoiding excess, and heating gently. When all is dissolved, add 2·25 litres of cold water, and add gradually ammonia until the liquid is neutral to litmus paper. Dissolve separately 70 grms. sal-ammoniac in water, and mix with the former solution, and make up to 10 litres with cold water. 2. Sulphate.—Dissolve 135 grms. of pure nickel in sulphuric acid diluted with twice its weight of water, and heat until the metal is dissolved. Add water and neutralise with ammonia. Dissolve separately 70 grms. ammonium carbonate, and neutralise the solution carefully with sulphuric acid. Add this liquid to the sulphate of nickel, and make up to 10 litres with cold water. In both cases filter the liquids or dilute after standing. M. Adams ascribes a good deposit of nickel to the absence of potassa or soda, whilst in reality excellent deposits may be obtained in ammoniacal baths containing salts of potassium or sodium.

No. 14, December 1, 1883.

Modification of the Leclanché Battery.—M. Bleunard uses plates of zinc and carbon, both immersed in a saturated solution of potassium bichromate and of ammonium sulphate or hydrochlorate. To prevent the ammoniacal salts from climbing up the carbon it is previously steeped in a bath of boiling paraffin, and its surface is then scraped with a knife.

Liquid for separating Minerals of Different Specific Gravities.—The liquid is prepared by mixing 100 parts barium iodide and 130 parts mercuric iodide with 20 c.c. of distilled water, and heating to from 150° to 200° in the oil-bath, concentrating until a topaz floats upon the liquid. Its sp. gr. is 3·57.

Lavoisier and Priestley.—M. Maumené protests indignantly against the reply of Colonel W. A. Ross to Professor Rodwell.

MEETINGS FOR THE WEEK

Monday, Jan. 21st.—London Institution, 5.
—— Medical, 8.30.
Tuesday, 22nd.—Royal Institution, 3. "Coins and Medals," by Mr. R. S. Foote.
—— Royal Medical and Chirurgical, 8·30.
—— Institute of Civil Engineers, 8.
Wednesday, 23rd.—Society of Arts, 8.
—— Geological, 8.
Thursday, 24th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
Friday, 25th.—Royal Institution, 8. "Kilima-njâro, the Snow-clad Mountain of Equatorial Africa," by Mr. H. H. Johnston.
—— Quekett Microscopical, 8.
Saturday, 26th.—Royal Institution, 3 "Life and Literature under Charles I.," by Prof. Morley.
—— Physical, 3. "On Direct Reading Electric Measuring Instruments," by Prof. Ayrton, F.R.S., and Prof. J. Perry. "On the Electromotive Force set up during Inter-diffusion," by Dr. C. R. Alder Wright, F.R.S., and Mr. C. Thompson.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1261.

THE MOLECULAR VOLUMES OF SALT SOLUTIONS.

By W. W. J. NICOL, M.A., B.Sc., F.R.S.E.,
Lecturer on Chemistry, Mason College, Birmingham.

MANY efforts have been made to establish a connection between the composition of a salt and its molecular volume; but all attempts to prove the existence of a law analogous to that of Kopp, in the case of organic liquids, have been but partially successful. This is to a great extent due to the state of molecular aggregation of the various salts not being the same, and the intermolecular spaces not being comparable but varying within comparatively wide limits: only in *strictly* isomorphous salts are the intermolecular spaces of the same magnitude.

In a paper in the *Philosophical Magazine* for August, 1883, I gave the results of various experiments on the molecular volumes of salt solutions of various strengths, and showed that in the case of the ten salts of potassium and sodium examined, the difference produced in the molecular volume of the solution by the substitution of the one metal for the other, or of one salt radical for another, was in each case a constant quantity, thus:—

$$(K-Na)Cl = 10{\cdot}0 \text{ to } 10{\cdot}48$$
$$(K-Na)\frac{SO_4}{2} = 10{\cdot}39 \text{ to } 10{\cdot}44$$
$$(K-Na)NO_3 = 10{\cdot}36$$
$$(K-Na)ClO_3 = 10{\cdot}56$$
$$(K-Na)OH = 10{\cdot}06$$

Also—

$$K(NO_3-Cl) = 10{\cdot}98 \text{ to } 11{\cdot}4$$
$$Na(NO_3-Cl) = 11{\cdot}28 \text{ to } 11{\cdot}51$$

$$K\left(Cl-\frac{SO_4}{2}\right) = 8{\cdot}55 \text{ to } 8{\cdot}91$$
$$Na\left(Cl-\frac{SO_4}{2}\right) = 8{\cdot}49 \text{ to } 9{\cdot}2$$

$$K(ClO_3-Cl) = 18{\cdot}82$$
$$Na(ClO_3-Cl) = 18{\cdot}41$$

"The volumes, therefore, of the above elements and groups of elements are independent of the manner in which they may be combined together provided only they be determined in solution in water and under the same conditions." Further, "When salts are dissolved in water, the molecular interspaces in various solutions are approximately co-extensive. Hence it is possible to ascertain the molecular volumes of the salts themselves with a degree of accuracy equal, at least, to that with which the molecular volumes of liquids have been determined."

I also gave an explanation of the variation (never reaching a unit) in the differences given above; this variation is due to the varying solubility of the salts, and may be proportional or not to the strength of the solutions compared.

The conclusions given above have been confirmed most strikingly by two more recent observers; the former of these—Groshaus, in a paper published in *Wiedemann's Annalen*, November, 1883—has taken the results of Kremers and others, and calculated the molecular volumes of various salt solutions; from these he subtracts the volume of water supposed to be constant, and obtains the so-called "*Reste*" (the volume of the salt in solution); this he subtracts from the molecular weight, and then he compares these figures—

$$(M\ wt.-r)-(M\ wt.'-r')=\Delta,$$

which is constant, just as the differences given by me are constant. He has compared *none* of the salts given by me, but his experiments leave no doubt of the *general* truth of my conclusions.

Bender (*Wiedemann's Annalen*, December, 1883) also has published a long paper with a view to prove the accuracy of the so-called *density moduli* of Favre and Palson. These moduli are numbers obtained by subtracting the densities of solutions of various salts from one another, and thus represent the change in density of a solution by the replacement of one metal by another, and so on. This is clearly the same result as I have obtained, but expressed in a different way. I may note that the results are rendered inexact to some extent by the variation of the quantity of water in the solutions compared.

Bender concludes his paper with a statement of his conviction that similar results will be obtained with organic compounds, "the radicals of which likewise will exist with constant modulus value in *any* solvent." Thus confirming most clearly my concluding words (*loc. cit.*):—

"This method of investigating the molecular volumes of salts is, in all probability, capable of extension to organic substances. . . . Such solutions need not necessarily be aqueous."

I therefore feel justified in stating the following law:—

In dilute solutions (1 equivalent to 200 H_2O) the volume of a metal in a salt is independent of the salt-radical with which it is combined, and the volume of the salt radical is independent of the metal.

I propose to more fully investigate the above points by means of the volume change in double decompositions attended by precipitation. I have already found that within narrow limits the volume change is constant in the reactions—

$$BaCl_2 + K_2SO_4 = BaSO_4 + 2KCl.$$
$$Ba(NO_3)_2 + K_2SO_4 = BaSO_4 + 2KNO_3.$$

And—

$$BaCl_2 + Na_2SO_4 = BaSO_4 + 2NaCl.$$
$$Ba(NO_3)_2 + Na_2SO_4 = BaSO_4 + 2NaNO_3.$$

In this way, too, I hope to be able to solve the much vexed question—Is water of crystallisation distinguishable from water of solution when the salt is dissolved? My experiments at present lead me to believe that it is *not*, but that *water of constitution is capable of recognition in solution*.

ON THE DETERMINATION OF THE ATOMIC WEIGHT OF OXYGEN.

By THOMAS HILDITCH.

IN all the atomic weight determinations of oxygen which have hitherto been made, hydrogen has been used which has been obtained by the solution of impure zinc in sulphuric acid, most of the impurities being removed by passing the gas over various absorbing reagents. The object of this paper is to point out some possible sources of error and to calculate the effect of these errors or impurities in the hydrogen on the result.

The most elaborate series of experiments which have as yet been made for this purpose were conducted by Dumas in conjunction with Stas* in the year 1842, and I think I shall succeed in showing that the numbers he and others† have obtained has but little weight, and also in showing the necessity of its re-determination, using methods which avoid these possible errors.

In Dumas's experiments zinc was dissolved in dilute sulphuric acid. His absorbing reagents consisted of solid silver sulphate, caustic potash, both in solution and in the solid form, a solution of lead nitrate, and, as a drying substance, either sulphuric acid or phosphorus pentoxide,

* *Compt. Rend.*, 14, 537.
† CHEMICAL NEWS, vol. xlvii., p. 275.

The impurities to be looked for in the gas as thus prepared are:—Hydrides of carbon, sulphur, antimony, and arsenic, sulphur dioxide, and carbon dioxide, oxides of nitrogen, free oxygen, nitrogen, and water; so that of these his absorbing reagents would allow to pass hydrides of carbon, nitrous and nitric oxides, and free oxygen and nitrogen. Hydrocarbons may be derived from zinc, which may possibly have contained carbon in a form similar to that contained in steel, and in which case it would be liberated as hydrocarbons on dissolving the zinc in sulphuric acid. Another possible source of hydrocarbons is from the indiarubber used in making the connections which may have retained some of the volatile hydrocarbons used in its preparation, and have given them up to the stream of hydrogen passing. The lower oxides of nitrogen would be generated by the action of hydrogen sulphide on the lead nitrate, while free oxygen and nitrogen are extremely liable to find access by diffusion through some of the indiarubber connections, or through the substance of the indiarubber itself (Graham), or even through a minute orifice or crack in some of the glass apparatus. It is noteworthy that none of the earlier experimenters appear to have applied any adequate test for the detection of either oxygen or carbon in their hydrogen, and the presence of the former is rendered the more probable by the difficulties Prof. Roscoe met with in preparing hydrogen free from this element, for use in his vanadium researches.* Another important error, but one which, though very appreciable, affects the determination only to a comparatively slight extent, is one which affects all weighings not made *in vacuo*, and is due to the power which all solid bodies appear to possess of condensing on their surfaces and gas with which they come in contact,† and is therefore greater the greater the surface exposed. In compact solids it is perhaps inappreciable, but with those in a fine state of division it may easily be estimated; but being a physical property will vary in different samples even of the same compound. A sample of copper oxide precipitated from a dilute boiling acid copper solution by a hot dilute solution of pure caustic potash I found to weigh 0·011 per cent heavier when weighed in dry air than it did when weighed *in vacuo*. This is quite independent of the error due to the displacement of the air.

Hence, in any future determination of this most important element, oxygen, the source of the hydrogen must be the electrolysis of water, rendered conducting by a suitable substance dissolved in it. Oxygen, always liable to find entrance by diffusion, may be removed by Prof. Roscoe's method by passing the gas through a hot tube containing spongy platinum, and afterwards drying the gas by means of sulphuric acid or of phosphorus pentoxide.

In these calculations 16 is assumed as the true atomic weight of oxygen, and a positive error of 0·01 means that the atomic weight will appear to be 16·01 instead of 16·00, and a negative error is to be taken the other way.

The presence of 0 0006 per cent C. in the zinc, and that equals 0·02 per cent by weight in the hydrogen, supposing it to be completely evolved as a volatile hydrocarbon on the solution of the metal in acid, and then to be completely burnt to CO_2, would cause a positive error of 0·01.

The presence of 0·111 per cent oxygen by weight, or of 0·007 per cent by volume, causes a negative error of 0·01. If oxides of nitrogen be present, then part of the nitrogen is reduced to ammonia, thereby further increasing the negative error. Free nitrogen appears to be unacted on under the conditions of this experiment.

For the third error, if the sample of copper oxide used should condense 0·006 per cent of its weight of air, this causes a positive error of 0·01 if the copper oxide is weighed in air and the reduced copper *in vacuo*; but if the oxide of copper is weighed *in vacuo* while the reduced copper is weighed in air an error of 0·008 per cent in the weighing of the copper causes a negative error in the atomic weight of 0·01. Since part of the phosphorus pentoxide used to absorb the water will deliquesce during the experiment and will then offer less surface for condensation, a slight positive error arises which it is impossible to calculate.

Sir Joseph Whitworth and Co., Limited,
Manchester, Jan. 9, 1884.

* Roscoe. *Phil. Trans.*, 1868 and 1869.
† Roscoe and Schorlemmer's "Treatise on Chemistry," vol. i., p. 594.

ON THE

USE OF LITMUS, ROSOLIC ACID, METHYL ORANGE, PHENACETOLIN, AND PHENOLPHTHALEIN AS INDICATORS.*

Part II.

By ROBERT T. THOMSON.

(Concluded from p. 35).

VII. *Borates of Calcium, Magnesium, Potassium, and Ammonium.*

In the former portion of this paper it was shown that the whole of the soda could be estimated in borax by standard acid, for which purpose methyl orange alone was perfect, or indeed admissible. To acertain if the borates of calcium would yield corresponding results, 2 grms. of pure boric acid were dissolved in water, and a quantity of solution of calcium hydrate containing 0·1370 grm. of lime added. The solution of borate of calcium containing excess of boric acid thus obtained was then titrated with half-normal acid, of which 9·8 c.c. were consumed in two experiments, giving 0·1372 grm. of lime in each case.

Similar tests were made with the borates of magnesium, potassium, and ammonium, and in each compound the whole of the base was estimated with as great accuracy as in the borates of sodium and calcium.

It will now be evident that any of these borates may be determined by standard acid in samples of boric acid. Even the very smallest proportion of a borate can thus be detected. Methyl orange will also be found useful in the analyses of commercial borates of lime and boracite, but in titrating these it may be found necessary, in order to get them perfectly into solution, to add excess of the standard acid, then heat till dissolved, allow to cool, and titrate back with standard hydrate or carbonate of sodium.

VIII. *Phosphates of Calcium.*

The tricalcium orthophosphate (Ca_32PO_4) being insoluble in water has no effect on any of the indicators, while the monocalcium compound (CaH_42PO_4) is neutral (as will be demonstrated immediately) to methyl orange, but is strongly acid to litmus, rosolic acid, phenacetolin, and phenolphthalein. It would seem feasible, if a suitable indicator could be obtained (and this we have in phenolphthalein) to determine phosphoric acid in a solution containing the monocalcium phosphate with excess of a neutral calcium salt present, by adding standard hydrate of sodium to the boiling solution till all the tribasic calcium phosphate was precipitated. In any attempts I have met with to accomplish this object, the separation of the lime is insisted on as necessary on the ground that ordinary superphosphates contain sulphate of calcium, which would be decomposed by the carbonate of sodium employed for titration, and give high results. Now this difficulty can be overcome by employing hydrate of sodium free from carbonate, but unfortunately another and insuperable difficulty renders such a process useless. This is shown by the following experiments:—A solution was prepared by dissolving a weighed quantity of pure tricalcium phosphate in hydrochloric acid, diluting, and adding caustic soda till the solution, which had been

* Read before the Chemical Section of the Glasgow Philosophica Society, December 10th, 1883.

coloured pink with methyl orange, was rendered distinctly yellow. The mixture was then made up to a certain volume, so that 50 c.c., the quantity used for each test, contained phosphoric acid and calcium exactly equivalent to 0·62 grm. of Ca_32PO_4. After addition of phenolphthalein half-normal caustic soda (1 c.c. of which will, under the circumstances, be equal to 0·03875 grm. of Ca_32PO_4) was added, the first two drops producing a faint but distinct precipitate, until after boiling well, a permanent red colour was produced, showing that all the phosphate of calcium was precipitated. Other tests were made with the same quantity of phosphate solution to which had been added various proportions of pure calcium chloride. The following were the results :—

0·6200 grm. Ca_32PO_4	really present.	
0·6225 ,, ,,	obtained without addition of $CaCl_2$.	
0·6400 ,, ,,	,, after adding	0·055 grm. $CaCl_2$.
0·6614 ,, ,,	,, ,,	0·111 ,,
0·6750 ,, ,,	,, ,,	0·555 ,,

These results show that a basic phosphate must be to some extent produced, the amount being greater when the proportion of neutral calcium salt present is greater, although even in the experiment made with the smallest quantity of calcium chloride, the most part of that compound remained in solution after the titration was finished. By the first of these tests, that made with the pure phosphate solution without addition of calcium chloride, it is proved that the monocalcium phosphate (CaH_42PO_4) is neutral to methyl orange, because if it were not so, the result would have been either high or low, whereas it is at least within the limits of error. In corroboration of thls, it has been already noted that the neutral point obtained by the use of methyl orange comes very close to that shown by the ordinary method of adding alkali till a faint precipitate appears. As would be expected the methyl orange indicates neutrality just before any precipitate is produced, and to verify the fact several additional tests were made. It may be worthy of a passing note to mention that when the titration described above is accomplished in the cold, much less of the alkali is consumed, the whole of the phosphoric acid is precipitated, but a considerable portion of the lime remains in solution. On boiling, the colour is dispelled, and the same results as those quoted above are obtained.

Having now discovered sufficiently grave reasons to discard the process described above, is will be well to examine the "New Method for the Volumetric Determination of Phosphoric Acid in the Superphosphates" proposed by A. Mollenda (CHEMICAL NEWS, vol. xlvii., page 231). This process consists in adding an alkali to the solution in which the phosphoric acid is to be determined, until a faint precipitate appears, then precipitating the lime in a boiling solution with oxalate of sodium, filtering off the oxalate of calcium, and titrating the filtrate, which now contains the monosodium phosphate (NaH_2PO_4) with hydrate or carbonate of sodium, using litmus, phenacetolin, or phenolphthalein as indicator. The author of the article prefers the latter indicator, and in that case caustic soda or potash must be used. In the first part of this paper I proposed a similar method for the determination of phosphoric acid in phosphate of sodium, which depended on the difference of indication shown by methyl orange and phenolphthalein, but in this case the former indicator cannot be employed after precipitation of lime, as oxalate of sodium acts like an alkali toward it. It may be used in the neutralisation before precipitating the lime, instead of depending on the less exact appearance of a faint precipitate. In two determinations made with 0·62 grm. of pure tricalcium phosphate by Mollenda's method thus modified, 7·9 and 7·95 c.c. of half-normal caustic soda were consumed respectively. As the equivalent of 1 c.c. in Ca_32PO_4 is 0·0775 grm., the amounts thus brought out gave as an average 0·6142 grm. These quantities are decidedly too low, but the difference may be accounted for partly through a little of the phosphate being precipitated along with the oxalate of calcium, but must be chiefly assigned to the slight alkalinity of disodium phosphate (Na_2HPO_4), produced by the action of the sodium hydrate. An allowance, based on tests made with pure disodium phosphate, of 100th part of the whole phosphate present will eliminate the error thus caused. With regard to the use of litmus or phenacetolin in place of phenolphthalein, I can only repeat what was noted formerly, that not only are the neutral points indicated by the two former entirely different from the latter, but the end-reactions are so uncertain as to render them useless where anything approaching to trustworthy results are required.

A few experiments were next devoted to the estimation of phosphate of calcium in presence of iron. The solution employed contained 0·62 grm. of phosphate of calcium and perchloride of iron equivalent to 0·006 grm. of ferric oxide. Carrying out Mollenda's process *unmodified* (that is, utilising the production of the faint precipitate to indicate the neutral point) three experiments gave 0·7002 and one test gave 0·7020 grm. of Ca_32PO_4. These results are so extremely high that they would give a difference of 3 or 4 per cent in an ordinary superphosphate of average strength. The results were the same when the preliminary neutralisation was done in a boiling solution. More alkali was required to effect the preliminary neutralisation when methyl orange was employed, and at the same time a considerable precipitate was produced. The precipitate was collected, and on applying the necessary tests proved to be pure phosphate of iron. It weighed 7 milligrms., and thus contained about two-thirds of the total iron present. The filtrate was then treated with sodium oxalate, and titrated with half-normal caustic soda, and on adding the weight of the ferric phosphate precipitate, the total amount agreed with those obtained from pure tricalcium phosphate.

A small quantity of aluminium was found to have the same effect as iron, and it is evident that these two metals must be removed, as otherwise, even if they remain in solution, correct results cannot be expected. These results show that, in constructing a method of chemical analysis, every possible, and even what may with some show of reason be considered impossible, source of error must be taken into account, and the subject carefully worked out.

The accuracy of the process does not seem to be affected by neutral magnesium salts, but it cannot be applied directly to superphosphates containing ammonium salts, as these injure the delicacy of the phenolphthalein. On the whole no more can be said in favour of this method than that, under suitable circumstances, it will give a near approximation to the truth.

IX. *Behaviour of the Indicators with Carbolic Acid, &c.*

Having had occasion to test directly the alkalinity of a certain ammonia liquor, among other indicators I used rosolic acid, and found the pink colour at first developed was quickly destroyed, and could not be brought back with caustic soda. This led to testing the action of carbolic acid, with the result that that body was found to be neutral to litmus, rosolic acid, methyl orange, and phenacetolin, and that none of these was destroyed even after prolonged contact. Two grms. of pure phenol dissolved in water and phenolphthalein added, required 1·2 c.c. of half-normal alkali to produce a faint red colouration, but a considerable additional quantity was required to bring out the full intensity of colour. The result shows that 100 parts of phenol require 0·63 grm. of soda (Na_2O) to make it neutral to phenolphthalein, but the end-reaction is extremely indistinct.

On another occasion I wished to determine the soda in a solution of sodium sulphide prepared by passing sulphuretted hydrogen through caustic soda, and found that, on adding acid in excess, the methyl orange employed seemed to have been destroyed and gave no pink colour. There was a little sulphur precipitated, and thinking that it might have some reducing action, I made a test

Table of the Behaviour of Litmus, Rosolic Acid, Methyl Orange, Phenacetolin, and Phenolphthalein as Indicators in the Determination of Alkali by Standard Acids, and of Acids by Standard Alkali.

In the following table are given the parts by weight of base or acid which can be estimated by standard acid or alkali in the various compounds, when 100 parts of the base or acid are present. The figures relating to the fats and fatty and resin acids are given on the authority of Hehner and Allen. When the end-reaction is noted as "uncertain," it must be understood that the indicator is practically useless, unless specified otherwise in a note.

Compounds Titrated.	Condition of Solution.	Per cent of Base Estimated with				
		Litmus.	Rosolic Acid.	Methyl Orange.	Phenacetolin.	Phenolphthalein.
$KHO, NaHO,$	Cold	100	100	100	100	100
$Ca(HO)_2,$	Boiling	100	100	100	100	100
$Ba(HO)_2$	End-reaction	delicate	delicate	delicate	delicate	delicate
NH_4HO	Cold	100	100	100	100	97
	End-reaction	delicate	delicate	delicate	delicate	uncertain
$K_2CO_3,$	Cold	—	—	100	—	50*
Na_2CO_3	Boiling	100	100	—	100	100
	End-reaction					uncertn (cold)
						delicate (hot)
$(NH_4)_2CO_3$	Cold	—	—	100	— †	cannot be
	End-reaction	—	—	delicate	—	used at all
$CaCO_3,$	Cold	—	—	100	—	0‡
$BaCO_3$	Boiling	100	100	—	100	0
	End-reaction	delicate	delicate	delicate	delicate	—
$NaHCO_3,$	Cold	—	—	100	—	0
$KHCO_3,$	Boiling	100	100	—	100	100‖
$CaH_2(CO_3)_2$	End-reaction	delicate	delicate	delicate	delicate	delicate (hot)
$MgO,$	Cold	—	—	100	—	—
$MgCO_3$	Boiling	100	100	—	100	100
	End-reaction	delicate	delicate	delicate	delicate	delicate
$Na_2SO_3,$	Cold	about 50	0·4	50	about 50	0·4
K_2SO_3	Boiling	—	10·2	—	—	8·0
	End-reaction	uncertain	delicate	delicate	uncertain	delicate
$(NH_4)_2SO_3$	Cold	about 50	0·4	50	about 50	cannot be
	End-reaction	uncertain	delicate	delicate	uncertain	used
$CaSO_3,$	Cold	about 50	0·4	50	about 50	0·4
$MgSO_3$	End-reaction	uncertain	delicate	delicate	uncertain	delicate
$Na_2S,$	Cold	—	—	100	—	50
K_2S	Boiling	100	100	—	100	100
	End-reaction	delicate	delicate	delicate	delicate	uncertn (cold)
						delicate (hot)
$(NH_4)_2S$	Cold	—	—	100	— §	cannot be
	End-reaction	—	—	delicate	—	used
$Na_2HPO_4,$	Cold	about 50	about 50	50	about 50	1·0
K_2HPO_4	Boiling	about 50	about 50	—	about 50	5·5
	End-reaction	uncertain	uncertain	delicate	uncertain	delicate
$(NH_4)_2HPO_4$	Cold	about 50	about 50	50	about 50	cannot be
	End-reaction	uncertain	uncertain	delicate	uncertain	used
$NaH_2PO_4,$	—	acid	acid	neutral	acid	acid
$KH_2PO_4,$	End-reaction	—	—	delicate	—	—
$CaH_4(PO_4)_2$						
Silicates of	Cold	100	—	100	100	88
Na and K	Boiling	100	100	—	100	90
	End-reaction	delicate	delicate	delicate	delicate	uncertain
Borates of	Cold	100	100	100	100	46¶
Na, K, NH_4,	Boiling	100	100	—	100	67
Ca, and Mg	End-reaction	uncertain	uncertain	delicate	uncertain	uncertain

TABLE (*continued*).

Compounds Titrated.	Condition of Solution.	Per cent of Base Estimated with: Litmus.	Rosolic Acid.	Methyl Orange.	Phenacetolin.	Phenolphthalein.
Al_2O_3 (freshly precipitated)	Cold	--	—	about 100	0	0
	Boiling	1	1	—	0	0
	End-reaction	delicate	delicate	uncertain**	delicate	delicate

Compounds Titrated.	Condition of Solution.	Per cent of Acid Estimated with: Litmus.	Rosolic Acid.	Methyl-Orange.	Phenacetolin.	Phenolphthalein.
H_2SO_4, HCl, HNO_3	Cold	100	100	100	100	100
	End-reaction	delicate	delicate	delicate	delicate	delicate
$H_2C_2O_4$	Cold	100	100	90	100	100
	End-reaction	delicate	delicate	uncertain	uncertain	delicate
$HC_2H_3O_2$	Cold	99·8 ††	100	12	96	100
	End-reaction	uncertain	uncertain	uncertain	uncertain	delicate
$H_2C_4H_4O_6$	Cold	100	100	80	99	100
	End-reaction	somewhat indistinct	somewhat indistinct	uncertain	uncertain	delicate
$H_3C_6H_5O_7$	Cold	98·5 ††	99	45	86	100
	End-reaction	uncertain	uncertain	uncertain	uncertain	delicate
Phenol	Cold	neutral	neutral	neutral	neutral	100 grms. phenol consumes 0·63 grm. Na_2O
	End-reaction	delicate	delicate	delicate	delicate	uncertain

Fatty and resin acids and neutral fats. The following substances can be determined by standard alcoholic potash, with phenolphthalein as indicator. One c.c. normal caustic potash (1 c.c. = 0·056 grm. KHO) is equal to:—

0·088 gramme	butyric acid	0·1007 gramme	tributyrin
0·282 ,,	oleic ,,	0·2947 ,,	triolein
0·256 ,,	palmitic ,,	0·2687 ,,	tripalmitin
0·284 ,,	stearic ,,	0·2967 ,,	tristearin
0·410 ,,	cerotic ,,	0·676 ,,	myricin
0·329 ,,	resin acids (ordinary colophony, chiefly sylvic acid).		

* The end-reaction is distinct when only small quantities (say not more than 0·1 grm.) of the carbonate are present.
† Litmus, rosolic acid, or phenacetolin can be used if excess of acid is added, the solution boiled, and titrated back with alkali.
‡ 50 per cent is estimated if $CaCO_3$ (but not $BaCO_3$) is freshly precipitated, but not after boiling.
‖ This only applies to the sodium and potassium salts.
§ See Note †.
¶ This does not apply to ammonium borates.
** End-reaction is tolerably distinct when only small quantites of Al_2O_3 are present.
†† The standard NaHO used was standardised with normal H_2SO_4.

with a mixture of sulphite and thiosulphate of sodium, but the precipitated sulphur did not hinder the pink colour from appearing and remaining permanent. I have not yet had time to experiment further in the direction of solving these problems connected with rosolic acid and methyl orange.

In the Table is given an epitome of the results obtained in the first- and second parts of this paper, including a few results recorded by other chemists.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING DECEMBER 31ST, 1883.

By WILLIAM CROOKES, F.R.S.
WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.
and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, January 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from December 1st to December 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 168 samples of water, the whole were, without exception, clear, bright, and well filtered.

Altogether, the condition of the metropolitan water during the past month, in respect to aëration and freedom from colour and turbidity, has been unexceptionable. In one sample only out of those completely analysed was the amount of organic carbon at all excessive; while the mean proportion was low—and unusually low for the period of the year. This exceptional lowness in the amount of organic carbon, and consequently organic matter, was doubtless dependent on the exceptional character of the

season, and more particularly on the mildness of the temperature, and the absence of river floods.

We are, Sir,
Your obedient Servants,
William Crookes,
William Odling,
C. Meymott Tidy.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

CHROMIUM.

Concerning the atomic weight of chromium there has been much discussion, and many experimenters have sought to establish the true value. The earliest work upon it having any importance was that of Berzelius,† in 1818 and 1826, which led to results much in excess of the correct figure. His method consisted in precipitating a known weight of lead nitrate with an alkaline chromate, and weighing the lead chromate thus produced. The error in his determination arose from the fact that lead chromate, except when thrown down from very dilute solutions, carries with it minute quantities of alkaline salts, and so has its apparent weight notably increased. When dilute solutions are used, a trace of the precipitate remains dissolved, and the weight obtained is too low. In neither case is the method trustworthy.

In 1844 Berzelius's results were first seriously called in question. The figure for chromium deduced from his experiments was somewhat over 56; but Peligot‡ now showed, by his analyses of chromous acetate and of the chlorides of chromium, that the true number was near 52·5. Unfortunately, Peligot's work, although good, was published with insufficient details to be useful here. For chromous acetate he gives the percentages of carbon and hydrogen, but not the actual weights of salt, carbon dioxide, and water from which they were calculated. His figures vary considerably moreover, enough to show that their mean would carry but little weight when combined with the more explicit data furnished by other chemists.

Jacquelain's‖ work we may omit entirely. He gives an atomic weight for chromium which is notoriously too low, and prints none of the numerical details upon which his result rests. The researches which particularly command our attention are those of Berlin, Moberg, Lefort, Wildenstein, Kessler, and Siewert.

Among the papers upon the atomic weight under consideration that by Berlin is one of the most important.§ His starting point was normal silver chromate; but in one experiment the anhydrochromate $Ag_2Cr_2O_7$ was used. These salts, which are easily obtained in a perfectly pure condition, were reduced in a large flask by means of hydrochloric acid and alcohol. The chloride of silver thus formed was washed by decantation, dried, fused, and weighed without transfer. The united washings were supersaturated with ammonia, evaporated to dryness, and the residue treated with hot water. The resulting chromic oxide was then collected upon a filter, dried, ignited, and weighed. The results were as follows:—

Grms.		Grms.		Grms.	
4·6680	Ag_2CrO_4 gave	4·027	AgCl and	1·0754	Cr_2O_3.
3·4568	,,	2·983	,,	0·7960	,,
2·5060	,,	2·1605	,,	0·5770	,,
2·1530	,,	1·8555	,,	0·4945	,,
4·3335	$Ag_2Cr_2O_7$ gave	2·8692	,,	1·5300	,,

From these weighings three values are calculable for the atomic weight of chromium. The three ratios upon which these values depend we will consider seperately; taking first that between the chromic oxide and the original silver salt. In the four analyses of the normal chromate the percentages of Cr_2O_3 deducible from Berlin's weighings are as follows:—

23·037
23·027
23·025
22·968

Mean 23·014 ± 0·011

And from the single experiment with $Ag_2Cr_2O_7$ the percentage of Cr_2O_3 was 35·306.

For the ratio between Ag_2CrO_4 and AgCl, putting the latter at 100, we have for the former:—

115·917
115·883
115·992
116·033

Mean 115·956 ± 0·023

In the single experiment with anhydrochromate 100 AgCl is formed from 151·035 $Ag_2Cr_2O_7$.

Finally, for the ratio between AgCl and Cr_2O_3, the five experiments of Berlin give, for 100 parts of the former, the following quantities of the latter:—

26·705
26·685
26·707
26·650
26·662

Mean 26 682 ± 0·0076

These results will be discussed in connection with the work of other investigators at the end of this chapter.

In 1848 the researches of Moberg* appeared. His method simply consisted in the ignition of anhydrous chromic sulphate and of ammoniacal chrome alum, and the determination of the amount of chromic oxide thus left as residue. In the sulphate, $Cr_2(SO_4)_3$, the subjoined percentages of Cr_2O_3 were found. The brackets indicate two different samples of material, to which, however, we are justified in ascribing equal value:—

0·542 grm.	sulphate gave	0·212	Cr_2O_3.	39·114	per cent.
1·337	,,	0·523	,,	39·117	,,
0·5287	,,	0·207	,,	39·153	,,
1·033	,,	0·406	,,	39·303	,,
0·868	,,	0·341	,,	39·286	,,

Mean 39·1946 ± 0·0280

From the alum, $(NH_4)_2Cr_2(SO_4)_2.24H_2O$, we have these percentages of Cr_2O_3. The first series represents a salt long dried under a bell-jar at a temperature of 18°. The crystals taken were clear and transparent, but may possibly have lost traces of water,† which would tend to increase the atomic weight found for chromium. In the second series the salt was carefully dried between folds of filter-paper, and results were obtained quite near those of Berlin. Both of these series are discussed together, neither having a remarkable value:—(See next Table).

The determinations made by Lefort‡ are even less valuable than those by Moberg. This chemist started out from pure barium chromate, which, to thoroughly free it from moisture, had been dried for several hours at 250°. The chromate was dissolved in pure nitric acid, the

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Schweigg, Journ.*, 22, 53, and *Poggend. Annal.*, 8, 22.
‡ *Compt. Rend.*, 19, 609 and 734; 20, 1187; 21, 74.
‖ *Compt. Rend.*, 24, 679. 1847.
§ *Journ. f. Prakt. Chem.*, 37, 509, and 38, 149. 1846.

* *Journ. f. Prakt. Chem.*, 43, 114.
† This objection is suggested by Berlin in a short note upon Lefort's paper. *Journ. f. Prakt. Chem.*, 71, 191.
‡ *Journ. f. Prakt. Chem.*, 51, 261. 1850.

1·3185 grm. alum gave	0·213 Cr_2O_3.	16·155 per cent.	
0·7987 ,,	0·129 ,,	16·151 ,,	
1·0185 ,,	0·1645 ,,	16·151 ,,	
1·0206 ,,	0·1650 ,,	16·167 ,,	
0·8765 ,,	0·1420 ,,	16·201 ,,	
0·7680 ,,	0·1242 ,,	16·172 ,,	
1·6720 ,,	0·2707 ,,	16·190 ,,	
0·5410 ,,	0·0875 ,,	16·174 ,,	
1·2010 ,,	0·1940 ,,	16·153 ,,	
1·0010 ,,	0·1620 ,,	16·184 ,,	
0·7715 ,,	0·1235 ,,	16·007 ,,	
1·374 ,,	0·2200 ,,	16·012 ,,	

Mean 16·143 ± 0·0125

barium thrown down by sulphuric acid, and the precipitate collected upon a filter, dried, ignited, and weighed in the usual manner. The natural objection to the process is that traces of chromium may be carried down with the sulphate, thus increasing its weight. In fact, Lefort's results are somewhat too high. Calculated from his weighings, 100 parts of $BaSO_4$ correspond to the amounts of $BaCrO_4$ given in the third column:—

1·2615 grms. $BaCrO_4$ gave	1·1555 grms. $BaSO_4$.	109·174
1·5895 ,,	1·4580 ,,	109·019
2·3255 ,,	2·1340 ,,	108·974
3·0390 ,,	2·7855 ,,	109·101
2·3480 ,,	2·1590 ,,	108·754
1·4230 ,,	1·3060 ,,	108·708
1·1975 ,,	1·1005 ,,	108·814
3·4580 ,,	3·1690 ,,	109·119
2·0130 ,,	1·8430 ,,	109·224
3·5570 ,,	3·2710 ,,	108·744
1·6470 ,,	1·5060 ,,	109·363
1·8240 ,,	1·6725 ,,	109·058
1·6950 ,,	1·5560 ,,	108 933
2·5960 ,,	2·3870 ,,	108·756

Mean 108·9815 ± 0·0369

Wildenstein,* in 1853, also made barium chromate the basis of his researches. A known weight of pure barium chloride was precipitated by a neutral alkaline chromate, and the precipitate allowed to settle until the supernatant liquid was perfectly clear. The barium chromate was then collected on a filter, washed with hot water, dried, gently ignited, and weighed. Here again arises the objection that the precipitate may have retained traces of alkaline salts, and again we find deduced an atomic weight which is too high. 100 parts $BaCrO_4$ correspond to $BaCl_2$ as follows:—

81·87	81·57
81·80	81·75
81·61	81·66
81·78	81·83
81·52	81·66
81·84	81·80
81·85	81·66
81·70	81·85
81·68	81·57
81·54	81·83
81·66	81·71
81·55	81·63
81·81	81·56
81·86	81·58
81·54	81·67
81·68	81·84

Mean 81·702 ± 0·014

Next in order we have to consider two papers by Kessler, who employed a peculiar volumetric method entirely his own. In brief, he compared the oxidising power of potassium anhydrochromate with that of the chlorate, and from his observations deduced the ratio between the molecular weights of the two salts.

* Journ. f. Prakt. Chem., 59, 27.

In his earlier paper* the mode of procedure was about as follows:—The two salts, weighed out in quantities having approximate chemical equivalency, were placed in two small flasks, and to each was added 100 c.c. of a ferrous chloride solution and 30 c.c. hydrochloric acid. The ferrous chloride was added in trifling excess, and, when action ceased, the amount unoxidised was determined by titration with a standard solution of anhydrochromate. As in each case the quantity of ferrous chloride was the same, it became easy to deduce from the data thus obtained the ratio in question. I have reduced all of his somewhat complicated figures to a simple common standard, and give below the amount of chromate equivalent to 100 of chlorate:—

120·118
120·371
120·138
120·096
120·241
120·181

Mean 120·191 ± 0·028

In his later paper† Kessler substituted arsenic trioxide for the iron solution. In one series of experiments the quantity of anhydrochromate needed to oxidise 100 parts of the arsenic trioxide was determined, and in another the latter substance was similarly compared with the chlorate. The subjoined columns give the quantity of each salt proportional to 100 of As_2O_3:—

$K_2Cr_2O_7$.	$KClO_3$.
98·95	41·156
98·94	41·116
99·17	41·200
98·98	41·255
99·08	41·201
99·15	41·086
	41·199
Mean 99·045 ± 0·028	41·224
	41·161
	41·193
	41·149
	41·126
	Mean 41·172 ± 0·009

From the data given in the earlier paper, if we use our recent values for chlorine, potassium, and oxygen,

$K_2Cr_2O_7 = 293·937 \pm 0·086$
And from the latter, ,, 294·159 0·119

General mean ,, 294·013 0·0697

Finally, we come to the determinations published by Siewert,‡ whose work does not seem to have attracted general attention. He, reviewing Berlin's work, found that upon reducing silver chromate with hydrochloric acid and alcohol, the chromic chloride solution always retained traces of silver chloride dissolved in it. These could be precipitated by dilution with water; but, in Berlin's process, they naturally came down with the chromium hydroxide, making the weight of the latter too high. Hence too large a value for the atomic weight of chromium. In order to find a more correct value Siewert resorted to the analysis of sublimed, violet, chromic chloride. This salt he fused with sodium carbonate and a little nitre, treated the fused mass with water, and precipitated from the resulting solution the chlorine by silver nitrate in presence of nitric acid. The weight of the silver chloride thus obtained, estimated after the usual manner, gave means for calculating the atomic weight of chromium.

* Poggend. Annal., 95, 208. 1855.
† Ibid., 113, 137. 1861.
‡ Zeitschrift Gesammt. Wissenschaften, 17, 530. 1861.

His figures, reduced to a common standard, give, as proportional to 100 parts of chloride of silver, the quantities of chromic chloride stated in the third of the subjoined columns:—

0·2367 grm. Cr_2Cl_6	gave 0·6396 grm. AgCl	37·007
0·2946 ,,	0·7994 ,,	36·853
0·2593 ,,	0·7039 ,,	36·838
0·4935 ,,	1·3395 ,,	36·842
0·5850 ,,	1·5884 ,,	36·830
0·6511 ,,	1·76681 ,,	36·852
0·5503 ,,	1·49391 ,,	36·836
	Mean	36·865 ± 0·0158

The first of these figures varies so widely from the others that we are justified in rejecting it; in which case the mean becomes 36·842 ± 0·0031.

Siewert also made two analyses of silver anhydro-chromate by the following process:—The salt, dried at 120°, was dissolved in nitric acid. The silver was then thrown down by hydrochloric acid, and, in the filtrate, chromium hydroxide was precipitated by ammonia. Reduced to a uniform standard, we find from his results, corresponding to 100 parts of AgCl, $Ag_2Cr_2O_7$, as in the last column:—

$Ag_2Cr_2O_7$.	AgCl.	Cr_2O_3.	
0·7866 grm.	gave 0·52202	and 0·2764	150·684
1·089 ,,	0·72249	0·3840	150·729
		Mean	150·706 ± 0·015

Giving Berlin's single estimation equal weight with one of these, and combining, we get a general mean of 150·816 ± 0·074.

Siewert's percentages of Cr_2O_3, obtained from $Ag_2Cr_2O_7$, are as follows, calculated from the above weighings:—

35·139
35·262

Mean 35·2005 ± 0·0415

Combining, as before, with Berlin's single result, giving the latter equal weight with one of these, we have a general mean of 35·236 ± 0·0335.

For the ratio between silver chloride and chromic oxide, Siewert's two analyses of the anhydro-chromate come out as follows. For 100 parts of AgCl we have of Cr_2O_3:—

52·948
53·150

Mean 53·049 ± 0·068

This figure, reduced to the standard of Berlin's work on the mono-chromate, becomes 26·525 ± 0·034. Berlin's mean was 26·682 ± 0·0076. The two means combined give a general mean of 26·676 ± 0·074.

We may now consider the ratios before us, which are as follows:—

(1) Percentage Cr_2O_3 from Ag_2CrO_4, 23·014 ± 0·011
(2) Percentage Cr_2O_3 from $Ag_2Cr_2O_7$, 35·236 ± 0·0335
(3) AgCl : Ag_2CrO_4 : : 100 : 115·956 ± 0·023
(4) AgCl : $Ag_2Cr_2O_7$: : 100 : 150·816 ± 0·074
(5) AgCl : Cr_2O_3 : : 100 : 26·676 ± 0·0074
(6) Percentage Cr_2O_3 in chromic sulphate, 39·1946 ± 0·0280
(7) Percentage Cr_2O_3 in ammonia chrome alum, 16·143 ± 0·0125
(8) $BaSO_4$: $BaCrO_4$: : 100 : 108·9815 ± 0·0369
(9) $BaCrO_4$: $BaCl_2$: : 100 : 81·702 ± 0·014
(10) Molecular weight of $K_2Cr_2O_7$, 294·013 ± 0·0698
(11) AgCl : $CrCl_3$: : 100 : 36·842 ± 0·0031

From these ratios we can at once deduce five values for the molecular weight of Cr_2O_3, as follows:—

From (1) ..	Cr_2O_3 =	152·612 ±	0·074
(2) ..	,,	151·905	0·165
(5) ..	,,	152·634	0·044
(6) ..	,,	154·464	0·135
(7) ..	,,	154·512	0·125
General mean	,,	152·855	0·034

For barium chromate we get two values:—

From (8) ..	$BaCrO_4$ =	253·494 ±	0·094
(9) ..	,,	253·976	0·067
General mean	,,	253·816	0·054

From (3) we get	Ag_2CrO_4 =	331·739 ±	0·070
(4) ,,	$Ag_2Cr_2O_7$	431·470	0·215
(11) ,,	$CrCl_3$	158·102	0·018

Finally, from these intermediate data we derive six values for the atomic weight of chromium:—

From $BaCrO_4$	Cr =	53·200 ±	0·064
Cr_2O_3	,,	52·482	0·018
Ag_2CrO_4	,,	52·536	0·074
$Ag_2Cr_2O_7$	,,	52·188	0·109
$K_2Cr_2O_7$	,,	52·116	0·078
$CrCl_3$	,,	51·992	0·047
General mean ..	,,	52·453	0·015
Or, if O = 16 ..	,,	52·574	

On account of the wide discrepancies between different data, and of the known constant errors vitiating some of the series of experiments, the foregoing general mean can have but little real value. In fact, a careful consideration of all the work represented in it will show that the most accurate estimate of the atomic weight of chromium must be deduced from the experiments of either Berlin, Kessler, or Siewert. Berlin's figures, taken by themselves, and combined, give, if the single analysis of silver anhydro-chromate be assigned equal weight with a single analysis in the mono-chromate series, Cr = 52·389 ± 0·019; or, if O = 16, Cr = 52·511.

Siewert's results, both for chromic chloride and the silver anhydro-chromate, properly combined, give Cr = 52·009 ± 0·025. If O = 16, this value becomes Cr = 52·129. In brief, the atomic weight of chromium may be nearly 52·5, or it may be 52. Only a revision of all the experiments could enable us to decide positively between these values. But as Siewert has pointed out probable sources of error in Berlin's work, I am inclined to give preference to the lower value.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 17, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following gentlemen were declared by the Scrutators, Dr. Thorn and Mr. D. A. Louis, duly elected Fellows of the Society:—B. H. Brough, G. Daubeney, C. C. Hutchinson, W. S. Kilpatrick, E. Matthey, H. Peile, J. W. Pallister, R. Romanis, S. G. Rawson, F. M. Rogers, W. Robinson, T. Stenhouse, W. O. Senier, J. A. Voelcker.

The following certificates were read for the first time:—L. Archbutt, W. H. Barr, D. Bain, P. S. Chantrell, H. C. Draper, A. F. Damon, V. Edwards, W. T. H. Elsley, T. Hilditch, R. E. Moyle, P. Morton, W. J. Orsman, F. R. Power, H. G. Shaw, E. F. Smith, A. E. Simpson, A. Tarn.

The PRESIDENT then called on Mr. C. T. KINGZETT to read a paper "*On Camphoric Peroxide and Camphorate of Barium.*" Brodie states (*Phil. Trans.*, 1863, 407) that

when anhydrous camphoric acid is triturated with an equivalent quantity of hydrated barium peroxide in the presence of ice-cold water and the mixture filtered, there is obtained a solution which is slightly alkaline, and which, when rendered acid, has the following properties:—It bleaches indigo, oxidises potassium ferrocyanide, decomposes hydriodic acid, and evolves oxygen when heated, but fails to give a blue colouration with chromic acid, and does not discolour potassium permanganate. Brodie concluded from his analyses, &c., that a new substance was formed which was a barium salt of camphoric peroxide, $C_{10}H_{14}BaO_5$, and not a camphorate of barium peroxide. The author believes that Brodie's experiments admit of another explanation, which is probably correct, viz., that when camphoric anhydride is triturated with water and barium peroxide, the anhydride is first resolved by the addition of a molecule of water into camphoric acid, which in its turn decomposes barium peroxide, forming camphorate of barium and peroxide of hydrogen. The author then gives a detailed account of his repetition, with some slight variations, of Brodie's experiments: he concludes that barium peroxide only acts upon camphoric anhydride in the presence of water, and that the action is of a secondary character, the anhydride first becoming camphoric acid, which decomposes the peroxide of barium, and yields camphorate of barium. He also incidentally proves the existence of a crystalline hydrate of camphorate of barium containing one molecule of water.

$$C_{10}H_{14}O_3 + H_2O = C_{10}H_{16}O_4.$$
$$C_{10}H_{16}O_4 + BaO_2 = C_{10}H_{14}BaO_4 + H_2O_2.$$

Dr. Armstrong said that no doubt some organic peroxides, as acetic peroxide, did exist. In Mr. Kingzett's communication he had called attention to the results of one of his previous papers, in which he claimed to have shown that, by the air-oxidation of turpentine, camphoric peroxide was formed, which was the source of the peroxide of hydrogen; no doubt some peroxide was formed, but that this should be camphoric peroxide appeared to him very doubtful, as there seemed to be no relation between the terpenes and camphor.

Mr. Kingzett, in reply, said it was principally from Brodie's experiments that he had concluded that camphoric peroxide was formed in the oxidation of turpentine; although peroxides of monobasic acids were known, if camphoric peroxide did not exist, he did not think any peroxides of bibasic acids had yet been discovered.

The Secretary then read the following communications:—

"*Supplementary Note on Liebig's Production of Fulminating Silver without the use of Nitric Acid*," by E. Divers and Michitada Kawakita. The authors have succeeded in obtaining a very small quantity of fulminate by the action of nitrous acid, but under conditions which deprive its production of all significance. The fulminate was only produced when the temperature rose to about 60°, and the liquid contained nitric acid.

"*On the Decomposition of Silver Fulminate*," by E. Divers and Michitada Kawakita. Silver fulminate when treated with hydrochloric acid yields, as is the case with mercury fulminate, formic acid and hydroxy-ammonium chloride, but the authors have as yet only found two-thirds of the calculated quantity of each of these bodies. Traces of ammonia and hydrocyanic acid are also produced.

"*On Hyponitrites*," by E. Divers and Tamemasa Haga. In this paper the authors resume an investigation commenced by Divers in 1871. They criticise especially the results and conclusions of Berthelot and Ogier, who gave to silver hyponitrite the formula $Ag_4N_4O_5$. These chemists do not seem to have thought that an acid of such a strange constitution as $H_4N_4O_5$ might be a mixture of hyponitrite, having Divers's constitution (HNO), mixed with nitrite and nitrate. The authors of the present paper have made many experiments purifying the hyponitrite in various ways. The final experiment consisted in dissolving the hyponitrite in nitric acid, precipitating with sodium carbonate, washing with water, acetic acid, and again with water; all the operations being performed in an atmosphere of carbonic acid. This resolution and reprecipitation was performed several times. The product was finally dried in an atmosphere of carbonic acid over sulphuric acid. The salt gave 77·69 per cent of silver; AgNO contains 78·3 per cent. The constitution of the salt is therefore AgNO. The authors have hitherto failed to prepare hyponitrites either by Menke's method, heating potassium nitrate with iron filings, or by Zorn's process of using ferrous hydrate as the reducing agent.

Dr. Japp pointed out that Zorn had prepared an acid barium hyponitrite, and had shown that nitrous oxide was evolved when a hyponitrite was heated.

The Society then adjourned to Feb. 7th, when a paper "*On the Influence of the Temperature of Distillation on the Composition of Coal Gas*" will be read by L. T. Wright.

NOTICES OF BOOKS.

Bleaching, Dyeing, and Calico-Printing, with Formulæ. London: J. and A. Churchill.

Whoever first conceived the idea of producing a practical treatise on bleaching, dyeing, and calico-printing within the compass of 200 small pages has certainly given no bad proof of courage, and may be congratulated on the fact that the resulting work is more valuable than might have been reasonably expected. The recipes for producing various colours in dyeing and printing, though few in number, are well-selected, and are for the most part fairly on a level with modern practice.

The weakest part of the work is the section on dyewares, or, as the author prefers to call them, dye-stuffs. Some of much importance, such as gall-nuts, sumac, myrobalans, calliatura-wood, chestnut-bark, gardeniapods, monarda, sooranjee, tamarac, have been omitted. Among the aniline dyes we find in this section no mention of methyl and malachite green, though they are prescribed in some of the receipts for dyeing. On the other hand, certain colours, both natural and artificial, which figure here might have been omitted without any loss. Such are saffron, rhubarb, kermes, lo-kao, cinchonine, murexide, emeraldine, aldehyd green, &c There can be also little occasion in so small a book, intended for the use, not of the manufacturer of colours, but merely of the dyer, to describe the preparation and purification of aniline and anthracene.

By a curious oversight cam-wood is said to be a synonym for Brazil wood. Considering that the two differ in their origin, in the shades which they produce, in their fastness, and in the solubility of their respective colouring-matters, we are at a loss to account for this statement. Woad in these days is used in the vat for wool-dyeing, not as a dye, but merely as a promoter of fermentation. The notice of sulphate of indigo—the acid or "sour" form only—is mixed with instructions for vat dyeing in a manner which might prove perplexing to a beginner.

Concerning the adulterations of annatto, of which a formidable list is here given, on the authority of Dr. Hassall, we are somewhat sceptical. The alleged sophistications may possibly be found in samples purchased in the retail trade; but as obtained from the drug brokers and large drysalters it is fairly genuine. To incorporate turmeric with annatto, as alleged by Hassall and others, would be a tedious, and therefore unremunerative, operation.

A few typographical errors may be noted, in the probable event of another edition. Thus, for Tessié du Mothay, we find Tessié du Mathey; for ferrocyanide of tin, in the index, ferrocyanide of *tar*; for Hofmann violet, likewise

in the index, Hoffman violet, though the name is given correctly in the body of the work; for erythrosine, erythnosine, &c.

To sum up our opinion of this work we may say that the practical sections—those parts especially which appear to have been furnished by Mr. James Chadwick, of Manchester,—will prove useful, whilst the errors in the fourth chapter will soon be rectified by any person actually engaged in the tinctorial arts.

The Retrospect of Medicine. Edited by W. Braithwaite, M.D., and James Braithwaite, M.D. Vol. lxxxviii., July to December, 1883. London: Simpkin, Marshall, and Co.

Among the memoirs and abstracts here requiring notice is one by Dr. J. Lowe on the "germ-theory" of disease. The writer holds that germs may exist in wounds without producing evil, and that the antiseptic treatment proposed by Mr. Lister may be so modified that it is practically abolished, yet without involving the risk of blood-poisoning.

Dr. J. Milner Fothergill, in an article on "Stewed Fruit for the Gouty and Dyspeptic," proposes to neutralise, or partially neutralise, its acidity by the addition of alkaline carbonates. Concerning the medicinal value of fruit so prepared, we, of course, are not entitled to speak; but some quarter of a century ago it was once our evil lot to dine with a friend whose better half had a fancy for de-acidifying fruit pies on this principle. A more disagreeable flavour we rarely encountered.

Dr. C. H. Ralfe recommends caution in the use of picric acid as a test for modified albumen in urine, since it also precipitates mucine.

Dr. Oliver, for the detection of albumen in urine, proposes to add to a little of the suspected sample, potassium mercuric iodide and citric acid solution. If albumen is present a white precipitate almost immediately falls to the bottom of the tube. To adapt this test to medical use he prepares slips of paper, steeped respectively in the potassium mercuric iodide solution and in citric acid. The reaction may be successfully obtained by adding to the sample first a slip of the former paper and then one of the latter kind.

For the detection of sugar in urine he employs also two papers, the one prepared with sodium sulpho-indigotate—extract of indigo—and the other with sodium carbonate. One of each kind of paper is dropped into a test-tube, covered with water, and a drop or two of the urine in question is added. The whole is then boiled over a candle or gas flame. The colour of the extract of indigo dissolves out into the water, and if sugar is present the blue colour changes first to a green, then to a red, finally becoming yellow or colourless. On cooling and exposure to air the blue colour is gradually restored.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 26, December 24, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Verification of Galvanometers.—E. Ducretet.—Galvanometers ought to be frequently verified in consequence of the variations of the magnetic field, due especially to the variations of the directing magnet of the galvanometer. For this purpose the author transforms the directing magnet into a kind of electro-magnet, by fitting it with coils of wire of a certain resistance. In order to magnetise this bar of steel, he passes into the coils, for a given time, the current of several Daniells with large surfaces. The circuit of these coils being very resisting, the battery does not become polarised.

Researches on the Duration of the Solidification of Superfused Sulphur.—D. Gernez.—The duration of the solidification of the octahedral crystals is much longer than that of the prisms; being often 100 times greater, and rarely descending as low as 25 times.

The Decomposition which the Phosphates of the Earthy Alkaline Bases undergo in Presence of Water.—A. Joly.—The decomposition of these salts by water is of quite a different nature from that of bismuth nitrate, antimony chloride, &c. Not only the weight of free phosphoric acid increases constantly in the solution simultaneously with the weight of the mono-basic phosphate decomposed, but the relation between the total phosphoric acid and the combined phosphoric acid increases in the same manner. If further quantities of the salt are added it dissolves in the acid liquid without decomposition.

Heat developed on the Neutralisation of the Alkaline and Earthy-alkaline Bases by Hydrofluoric Acid.—M. Guntz.—A thermo-chemical paper, which does not admit of useful abstraction.

Creatines and Creatinines.—E. Duvillier.—The author gives an account of ethyl-amido-α-butyro-cyamidine. This compound, $C_7H_{13}N_3O$, forms fine, limpid, tabular, anhydrous crystals, which generally arrange themselves like the leaves of a half-open book. They are very soluble in water and alcohol.

Action of Ammoniacal Gas upon Methyl Nitrate.—E. Duvillier and H. Malbot.—The authors pass a current of ammoniacal gas into methyl nitrate mixed with about one-tenth of its volume of methylic alcohol, and contained in a flask fitted with a cohobator. The principal product of the reaction is tetra-methyl-ammonium nitrate, a salt very convenient for the preparation of pure tri-methylamine. Mono-methylamine is produced in smaller proportion, besides traces of di- and tri-methylamine.

Compound Oxygenated Ammonias.—M. Reboul.—By the action of epichlorhydrine upon diethylamine the author obtains hydroxallyl-tetrethyl-diamine, a very stable base which boils without decomposition, at the ordinary atmospheric pressure, at 236° to 238°. A homologue of this base, hydroxallyl-diethyl-diamine, is obtained by the action of epichlorhydrine upon ethylamine.

Certain Haloid Derivatives of Ethane.—L. Henry. The author describes mono-chlorinised ethylene bibromide ethylidene bibromide, and monobromised ethylene bibromide.

Calcium Chloro-silicate.—M. Le Chatelier.—The author has succeeded in obtaining this compound in distinct crystals.

No. 27, December 31, 1883.

The Action of Heat upon Aldol and Paraldol.—Ad. Wurtz.—The author has studied this action at 100°, 125°, and 170°. In the first place he describes the results obtained at the highest temperature. The principal product is crotonic aldehyd, which is formed along with water. But along with traces of regenerated aldehyd there are formed other products according to the nature of the aldol employed. If the latter is impure, giving off a strong odour of crotonic aldehyd, the product of the reaction is formed of two strata; the lower aqueous layer is colourless, whilst the higher stratum is deep brown or black, consisting principally of crotonic aldehyd, along with other products insoluble in water and of high boiling-points, to which the author will return in a future communication. With a purer aldol the product of reaction is colourless and homogeneous, containing a smaller quantity of crotonic aldehyd, and a compound soluble in water, which the author has particularly studied. It is a thick colourless

liquid, of the density 1·0941 at 0°. At the ordinary pressure it boils at 280°. Its formula is probably, $C_4H_8O_2$.

Reply to the Observations of M. Larroque on Experiments concerning the Study of Telluric Currents. —E. E. Blavier.—The author traverses a number of assertions made by M. Larroque in his recent communication to the Academy.

Temperature obtained by Means of Boiling Oxygen and the Solidification of Nitrogen.—S. Wroblewski.—Inserted in full.

Maximum Solubility of Sodium Sulphate. — E. Pauchon.—Kirchhoff's formula renders it possible to foresee and to determine the position of the maximum solubility of sodium sulphate.

An Incomplete Oxygenated Monamine, Oxallyldiethylamine.—E. Reboul.—This compound, which contains 65·1 per cent of carbon, 11·7 of hydrogen, and 10·8 of nitrogen, is a thick colourless liquid, extremely soluble in water, and of a strong odour, like that of diethylamine. It turns gradually yellow on exposure to light. Its boiling-point is 160°.

Sodium Fluorides.—M. Guntz.—A thermo-chemical paper, which does not admit of useful abridgment.

Researches on the Ptomaines and on Analogous Compounds.—A. Gabrial Pouchet.—The author's experiments have already led him to regard the alkaloidal compounds existing in the excretions as identical with, or at least closely similar to, those which take their rise during the putrefaction, in the absence of air, of proteic matters, and of various organs of the animal system. The basic bodies extracted from both these classes of matter are probably mixtures of homologous bodies. By a tedious process he obtains two distinct classes of compounds, a liquid portion, dialysable only with difficulty, and a portion containing crystallisable substances and readily capable of dialysis. For the former the author reserves for the present the name "extractive" matter of urine. Among the products of putrefaction the same two classes of compounds are recognised. The volatile bases found in the crystallisable portion resemble the hydropyridic bases detected by MM. Gautier and Etard. All the compounds isolated are violent poisons for frogs which they kill rapidly, occasioning torpor and paralysis, with abolition of the reflex movements.

Action of Copper upon the Human Economy: History of a Workshop and of a Village.—MM. A. Hulés and De Pietra-Santa.—The authors give an account of Durfort, a village of Tarn, where the workmen pass twelve hours daily in the midst of an atmosphere of copper oxide. Their skins, hair, and beards are coloured with copper. The same metal can be detected in their secretions and excretions, and after death in their bones. These people suffer from no special trade disease, and on the other hand they enjoy no special immunity from infectious diseases, and in particular from cholera or typhoid fever.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 11.

The Water of the Danube, and the Projected Irrigation of the Marchfeld.—J. F. Wolfbauer.—In 10,000 parts of Danube water the author found potassium sulphate 0·034, sodium nitrate 0·028, and organic matter 0·056. There is here no mention of phosphates, though it is afterwards stated that if the Marchfeld receives during the season of 180 days 18,000 cubic metres of water per hectare, the soil would be enriched with 4·1 kilos. phosphoric acid.

Chemical Procedures in the Soil and in Subsoil Waters, and their Sanitary Importance.—F. Hoppe-Seyler.—The author argues that a soil can be judged from a sanitary point of view neither from the carbonic acid found in the ground-air, nor from the nitrous and nitric acid in the subsoil waters. He contests the notion recently promulgated that the bodies putrefying in churchyards, &c., are harmless.

Forest as a Protection against Hail.—Prof. L. Glaser.—A number of observations made in Switzerland, Italy, &c., showing that the clearing of mountain ridges has been followed by an increase of hail-storms.

Hygroscopic Power of Soils as regards the Submersion of Vineyards.—P. Pichard.—From the *Comptes Rendus*.

Contributions to the Development of the Theory of Manures.—Prof. Paul Wagner.—In this extensive memoir the author points out as essential in all manurial experiments:—(1) Equalisation of all the factors of fertility (especially of the moisture of the soil), with the single exception of the agent to be tested. (2) Diminution of experimental errors by adding together the results of a sufficient number of parallel experiments, and by bringing to bear as far as possible the relative maximum or optimum of all the factors of fertility, with the exception of that (or those) in question. (3) Determination of the limits of error.

MISCELLANEOUS.

Society of Arts.—On Monday, the 28th inst., Mr. Thomas Bolas will deliver, at the Society of Arts, the first of a Course of Cantor Lectures on "Recent Improvements in Photo-Mechanical Printing Processes," in which he will deal with new developments of the Woodbury type process. The second lecture, on February 4th, will be on type blocks from line drawings and half tone subjects; and the third and concluding one on February 11th, will be devoted to the consideration of intaglio plates, collotypes, photo-mechanical methods as applied in the decoration of pottery and miscellaneous processes.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Soapstone.—In your issue of November 23rd a correspondent (J. H. T.) asks for uses of soapstone. Allow me to mention a few I know of. Soapstone in lumps is cut into gas-burners, electric insulators, griddles, slate pencils, hair curlers or crimpers, linings for stoves, &c. In making gas-burners and insulators, it is turned to the proper form in a lathe, the stone being quite soft in its natural condition. When finished, the result is heated to a red heat in a suitable furnace, then cooled slowly, when we get a very hard and yellowish coloured article, unacted on by moisture and acids. The turnings and dust are largely used for mixing with lubricating compounds, also for making cements, using silicate of soda as an agent.—X. Y. Z.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 28th.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "Recent Improvements in Photo-Mechanical Printing Methods," by T. Bolas, F.C.S.

TUESDAY, 29th.—Institute of Civil Engineers, 8.
— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.
— Society of Arts, 8. "Canada as it will appear to the British Association in 1884," by Joseph G. Colmer.

WEDNESDAY, 30th.—Society of Arts, 8. "Coal-gas as a Labour-saving Agent in Mechanical Trades," by T. Fletcher, F.C.S.

THURSDAY, 31st.—Royal, 4.30.
— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
— London Institution, 7.

FRIDAY, Feb. 1.—Royal Institution, 8. "Rajah Rammohun Roy," by Prof. Max Müller, at 9.

SATURDAY, 2nd.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1262.

ON A NEW METHOD OF GENERATING ELECTRICITY.*

By J. A KENDALL, F.I.C., F.C.S.

In 1863 Deville and Troost announced their discovery that certain metals were permeable by hydrogen at a red heat. This discovery, as is well known, was verified by Graham, who made extended researches on the subject.

About three years ago it occurred to the author that a red-hot platinum plate, through which hydrogen was passing, might be made to serve as an element of a galvanic combination, and early in 1881 some experiments were tried with this object.

These were continued from time to time up to the present, and in this paper it is proposed to give some account of the experiments and their results. The subject appears to the author to require much more extended researches in several directions than he has been able to make, but it is hoped that by giving an account of the researches hitherto made, the points which require further investigation will suggest themselves to physicists and chemists.

In the earlier experiments the author constructed small tubes of platinum foil. These were sealed up at one end by the oxy-hydrogen blowpipe, and to the open ends glass tubes were fused. Platinum conducting wires were fastened to the tubes. By means of the glass tubes gases could be conveyed to the interior of the platinum tubes.

A platinum crucible was used at the other element of the cell, it had a platinum conducting wire attached, and was supported over a Bunsen burner. A small platinum foil tube was then held in the centre of the crucible, and the cell was completed by putting the transmitting medium into the crucible. After unsuccessful trials with alkaline nitrates, &c., glacial phosphoric acid was selected. Some of this substance was put into the crucible and fused so as to nearly immerse the platinum foil tube.

On connecting the two wires with a galvanometer no deflection was observed when the crucible and contents were heated to redness in the oxidising flame of the Bunsen burner. When, however, hydrogen gas was supplied to the inner platinum tube, an immediate production of electricity was perceived. The tube of platinum foil containing hydrogen was seen to correspond to the zinc element in an ordinary galvanic cell.

This experiment being verified other substances were tried instead of phosphoric acid.

Sulphuric acid nearly at its boiling-point gave a slight current.

Chloride of sodium in the fused state gave a very good result. Then the chlorides of potassium, calcium, and the alkaline earth metals were tried with similar results.

As might be expected the production of electricity increased with the temperature.

It was, however, soon found that the production of the current was stopped if the flame of the Bunsen burner did not ensure perfect combustion on the exterior of the platinum crucible.

Experiments showed that if a reducing flame was applied to the crucible while the small tube contained air, then a current of electricity in the reverse direction was obtained.

Tubes of palladium foil substituted for the platinum tubes gave similar results.

After a number of trials with tubes of platinum foil, an apparatus was constructed of two platinum tubes closed at one end.

The inner tube was 4 inches long and $\frac{3}{8}$ inch internal diameter, while the outer tube was $3\frac{5}{8}$ inches long, and $\frac{5}{8}$ inside diameter. The thickness of metal was $\frac{1}{100}$ inch in both tubes.

The two tubes when used for these experiments were arranged upright in a small Fletcher's gas furnace, the inner tube being supported at any desired height in the centre of the larger tube and connected with a supply of hydrogen.

Numerous experiments were made with this apparatus. The temperature could be easily regulated from a dull red heat to a white heat, and various saline substances could be tried as media.

The fused sulphates, carbonates, and nitrates were found to be unsuitable for the production of the current. The results obtained with fused chlorides, &c., showed that the hydrogen not only passed through the metal of the inner tube, but also through the fused saline medium and then through the outer platinum tube.

In recent experiments with this apparatus it appears that when a good transmitting substance is used between the tubes, and when about 3·3 square inches of the inner tube are in contact with the medium, the amount of hydrogen gas which passes through the metal at a nearly white heat is about 0·7 cub. centim. per minute. This volume of course refers to hydrogen at ordinary temperatures.

The use of this apparatus led to the discovery of a large number of substances which would serve as media by allowing the transmission of hydrogen.

The list of saline bodies was extended to the bromides, iodides, and fluorides of the alkaline and earth metals, but the most important discovery in this direction was that vitreous bodies such as glass, and even vitrified bodies as porcelain and earthenware, acted as media when at a red heat. Attention was then directed to the use of vitreous media for several reasons.

In experiments with fused saline bodies the use of common metals was precluded owing to their being corroded by fused salts, and although iron is known to be permeable to hydrogen at a red heat, yet its oxidisable qualities prevented any satisfactory results being obtained when it was substituted for platinum.

However, when vitreous matters were used instead of fused salts, it became possible to use other metals for these experiments.

A number of trials were made by taking tubes of fusible soda-glass. A small tube of the metal to be tested was then placed inside the glass, and while passing a slight current of coal-gas to prevent oxidation of the metal, the glass was carefully fused on to the metal. The external surface of the glass while soft was then coated with thin platinum foil or with other metals.

On connecting the inner and outer coatings with a galvanometer, passing hydrogen through the tube, and then heating it to redness, the usual current of electricity was produced.

The quantity of electricity generated both with these cells and with the platinum tubes was in proportion to the surface heated.

The most powerful effects were obtained when the metallic coating was in the pulverulent form. Spongy platinum, for example, when made to adhere closely to the glass gave a strong current with hydrogen.

When using thin metallic plates in the interior of the tubes it was found necessary to employ very thin platinum foil on the exterior, as the hydrogen otherwise accumulated to some extent on the inner plate, thus spoiling the cell.

A good result might often be got by painting the external surface of the glass with an alcoholic solution of platinic chloride, and then igniting. By this means a very thin film of metallic platinum was left on the glass, and by means of a spiral of platinum wire also put round the glass, sufficient conduction was obtained.

* A Paper read before the Royal Society, Jan. 17th, 1884.

As glass exerts only a slight action on metallic iron at a red heat, thin sheet iron ($\frac{1}{100}$ inch) was used in numerous experiments, but this does not make a perfect arrangement when glass containing alkali is used, as the alkali metal is liberated by the iron at a very strong heat.

A number of metals were tried either in the form of sheet or as a powdery deposit.

This latter form might frequently be obtained by coating the interior of the glass tube with the oxide of the metal to be tried, and then reducing the metal by hydrogen or coal-gas upon the surface of the glass.

The following metals were tried and found to transmit hydrogen and cause the production of electricity:—

Platinum.	Molybdenum.
Palladium.	Copper.
Gold.	Silver.
Iron.	
Nickel.	

The relative transmitting powers were not, however, ascertained. There can be little doubt that the property of transmitting hydrogen at a red heat belongs to most, if not all, metallic bodies.

In the course of the experiments it was observed that the glass used was practically a non-conductor of electricity from one or two galvanic cells when it was heated to redness in an oxidising flame.

When, however, hydrogen was supplied to the glass either inside or outside of the tube it at once became a good conductor of the current.

It was found necessary to avoid using glass containing metallic oxides reducible by hydrogen, as these oxides by reacting upon the hydrogen on the surface of the transmitting plate cause frothing of the glass, thus destroying that absolute contact between the metal and the glass which is required for the production of the electric current.

Experiments were made with tubes of Berlin porcelain, and satisfactory results were obtained. It was found convenient to cover the surface of the tube both inside and out with melted glass and then to carefully lay platinum foil upon the glass, so as to get as perfect an adherence as possible. It appears to be best to have a much thicker metallic plate on the inner side of the cell than on the outside. The author has not determined the most advantageous conditions precisely as yet. Cells were also constructed of clay, containing a percentage of glass, porcelain of various kinds, &c.

The amount of hydrogen transmitted in a given time through the arrangement described varies greatly according to the nature of the medium and the nature of the metallic layer.

With pulverulent metals and a medium of soft glass the rate of transmission of hydrogen may be as high as 0·6 cub. centim. per square inch per minute at a full red heat. With Berlin porcelain tubes, however, the transmission does not usually exceed 0·2 cub. centim. per square inch per minute, even at a white heat, while at a red heat the rate is much lower. With platinum tubes of $\frac{1}{100}$ inch thick the transmission may be from 0·1 cub. centim. to 0·2 cub. centim. per square inch according to the temperature.

The electromotive force of the new cells varies according to the media used, and this subject will of course require further investigation. It was found, however, that the platinum tube cell gave, with borate of lime at a nearly white heat, an electromotive force = 0·36 of a Daniell, whilst a cell constructed of Berlin porcelain tube $\frac{1}{12}$ inch thick gave an electromotive force = 0·7 of a Daniell when worked at a nearly white heat.

Although many gaseous mixtures containing free hydrogen will serve to produce the electrical reactions, yet experiments with carbon monoxide have given no similar result in conjunction either with iron or platinum plates.

Before describing further researches which the author has made on the subject of electrical currents produced by hydrogen, it may be well to mention that the galvanometer generally used in the experiments yet to be described, as well as in the former experiments with metal tubes, &c., is one adapted for rather strong currents and it has very slight resistance. It has been graduated by means of a voltameter.

As these experiments must be regarded more as qualitative than quantitative, it will perhaps be sufficient to give four points of deflection with the corresponding liberation of hydrogen in a voltameter.

Deflection of galvanometer.	Liberation of hydrogen per minute.
10°	0·07 c.c.
20	0·21 ,,
30	0·60 ,,
40	1·35 ,,

The above figures also show, in a roughly approximate way, the amount of hydrogen which must be supplied to a cell of the new construction in order to give the deflection indicated.

In continuing his researches the author has found that strongly heated hydrogen may give rise to electrical currents under a variety of circumstances.

Small cells were made by nearly covering short wires or rods of metal with melted glass. The glass was then covered with platinum foil and the two metals were connected by wires with the galvanometer. On heating a cell of this construction in an oxidising flame an electrical current was almost invariably produced, due to the withdrawal of hydrogen from the inner wire or rod. When the current diminished in force a reducing flame containing free hydrogen was applied to the cell. This immediately caused an energetic reverse current, accompanied by the re-absorption of hydrogen by the inner metal. Then with an oxidising flame the original effect could be produced. These results were obtained with wires of platinum, nickel, iron, and copper. In working with cells of this description made with iron rod, it was found that a current of electricity of long duration could be produced by the oxidising flame. This result appears to be due to the continuous absorption of hydrogen liberated from aqueous vapour by that portion of the iron which was not covered by glass.

When the entire surface of the iron was covered by glass (with the exception of the conducting wire, which was away from the heat) then the deflection of the galvanometer gradually came to zero when the cell was heated in an oxidising flame.

Recently experiments have been made with a differently arranged apparatus, as follows:—

A platinum tube, 5¼ inches long and 1 inch diameter, was set upright in a Fletcher's gas furnace and nearly filled with a fusible glass composed of the diborates of lime and magnesia. This apparatus being heated to bright redness, a plate of platinum, 2 inches long and 0·6 inch wide, suspended by a platinum wire, was immersed in the fluid glass. The platinum tube and the plate being connected with the galvanometer, the phenomena of alternate electric currents could be produced with great facility by altering the nature of the flame in the furnace. When the platinum tube was surrounded with a visible pale flame there was an electrical current from the tube to the plate until the plate was apparently saturated with hydrogen. When more air was supplied to the furnace, so as to cause more perfect combustion, the needle of the galvanometer was violently reversed. The deflection produced on the galvanometer by either the "normal" or "reverse" current was at first 18° or 20°, and it fell to nearly zero within ten or fifteen minutes.

These effects could of course be repeated as often as required.

It appears quite plain that the hydrogen in flames has a powerful molecular or atomic action.

If glass be fused in a large platinum crucible heated by flame as in a Fletcher's furnace, bubbles of hydrogen may

be observed forming and rising from the sides of the crucible, especially at the hottest parts.

If a platinum tube like that used for the experiments with the suspended plate be somewhat cooled while nearly full of melted glass, so that the glass becomes very viscous, then by applying a flame containing free hydrogen to any spot on the lower part of the tube the latter may easily be burst by the bubble of hydrogen which is formed on the inside of the tube.

Experiments have also been tried in which the hydrogen coming through a cell was removed by means of a Sprengel pump. One experiment may be described:—A platinum tube 2⅝ inches long and ⅜ inch diameter, closed at one end, was soldered to a strong iron tube and fixed vertically. The platinum tube was immersed for 2¼ inches in fused glass contained in a platinum cell. This latter was 2¾ inches deep and 1 inch diameter.

The two platinum tubes were connected by platinum wires with the galvanometer, and the iron tube was connected with a Sprengel pump.

The cell being heated to bright redness in an oxidising flame, a good vacuum was produced by the Sprengel pump. Then, while no bubbles of gas came down the fall tube of the pump, the galvanometer showed no deflection.

The cell was then heated by a reducing flame. The galvanometer soon gave a steady deflection of 15°, and bubbles of hydrogen came down the fall tube of the pump. The experiment was continued for half an hour, and during fifteen minutes the hydrogen coming down the fall tube was collected. It measured 1·33 cub. centims.

From occasional experiments with several vitreous mixtures the conclusion formerly arrived at by the author regarding their electric conductivity is confirmed, viz., that these fused vitreous matters do not conduct electricity of low tension unless hydrogen be present. When working with large cells it is, of course, difficult to avoid the presence of hydrogen if the cell be heated by flame.

It appeared desirable to try whether any hydrogen could be made to pass through the walls of a porcelain tube either under the influence of oxygen or by means of a vacuum.

A glazed Berlin porcelain tube 20 inches long and ½ inch diameter was sealed up at one end and connected with a Sprengel pump. The closed end of the tube exposing a surface of 4 square inches was heated to whiteness in the gas furnace, but no hydrogen could be drawn by the Sprengel pump when the porcelain tube was heated in a reducing flame.

After this the porcelain tube was filled with hydrogen, and the same part as before was heated in an oxidising flame, but no loss of hydrogen from the tube could be perceived during half an hour.

Somewhat similar experiments have also been made with glass tubes with negative results.

The author has also made a few experiments to ascertain the influence of a voltaic current in increasing or diminishing the flow of hydrogen through the medium, but so much depends upon the structure of the metallic surfaces in contact with the medium and their relative sizes, as well as upon the electromotive force, &c., of the battery used, that this subject would probably require somewhat elaborate researches.

The author, however, hopes to make further investigations into the nature of the movements of hydrogen produced in vitreous matters and in metals.

Manufacture of Porous Earthenware by means of Naphthaline.—M. Stein works up the naphthaline into an emulsion with water, or comminutes it in any other convenient manner, and mixes it with the slip. The articles moulded are dried, and then heated sufficiently to expel the naphthaline by exudation or distillation. It is collected for re-using, and the earthenware is then burnt in the ordinary manner.—*Cosmos les Mondes.*

SEPARATION OF GALLIUM FROM TERBIUM, YTTERBIUM, AND THE EARTH PROVISIONALLY NAMED Y_α.

By M. LECOQ DE BOISBAUDRAN.

The terbia actually used in these experiments has been extracted from gadolinite and still contains much yttria, holmia, erbia, and Y_α. The author has examined the three following procedures:—

1. The hydrochloric solution is treated with an excess of boiling potassa, which dissolves gallium oxide; the last traces are removed by re-dissolving the earths in hydrochloric acid and repeating the treatment with potassa.

2. In the solution containing quarter to one-third of its volume of concentrated hydrochloric acid the gallium is precipitated by means of potassium ferrocyanide. The earths are found in the filtrate.

3. A solution of arsenious acid and an excess of acid ammonium acetate are added to the liquid, which is then treated with a current of sulphuretted hydrogen. The gallium is kept back by the arsenic sulphide from which it is separated in the manner already described.

This process is best adapted for the elimination of small quantities of gallium mixed with much earthy oxide.

Separation from Scandium.

This separation is effected by means of the two following methods, but it does not succeed with potassium ferrocyanide.

1. Scandium oxide is thrown down by boiling potassa, which readily dissolves gallium oxide. If accuracy is desired the scandia is re-dissolved in hydrochloric acid and again treated with potassa.

2. The gallium is thrown down by sulphuretted hydrogen in a liquid containing arsenious acid and an excess of acid ammonium acetate. This method is advantageous when there is but little gallium in the substance under examination.

Separation from Fluorine.

1. Gallium chloride is not precipitated by ammonium fluoride in a liquid acidified with hydrochloric acid. This property may be utilised for separating the gallium in the state of ferrocyanide, operating either in the cold or at a gentle heat upon a solution containing from quarter to one-third of its volume of concentrated hydrochloric acid. The fluorine is sought for and determined in the filtrate by known methods. In this manner there may be found either little gallium mixed with much alkaline fluoride, or very little fluoride mixed with much of a salt of gallium.

2. If the fluorine is not to be determined directly, it is merely needful to heat the substance with an excess of sulphuric acid until abundant white fumes are given off. The gallium is then extracted from the residue by means of one of the processes already described.

The fluorine may also be expelled by fusion with ammonium bisulphate.—*Comptes Rendus.*

ACTION OF DAYLIGHT AND OF THE ELECTRIC ARC-LIGHT UPON COLOURS USED IN DYEING AND IN PAINTING WITH WATER- AND OIL-COLOURS.

By M. DECAUX.

The author refers first to the researches of Dufay and Hellot undertaken in order to classify the colours into fixed and fugitive, and expresses regret that the rules based upon this regulation have been permitted to fall into abeyance.

As regards the action of sunlight or diffused daylight upon colours fixed in dyeing, M. Decaux proves by a long series of comparative experiments that the shades dyed

upon wool in the vat, with Prussian blue, cochineal, madder, weld, and even fustic, are much more permanent than those obtained with Nicholson blue, magenta, jaune d'or, and picric acid. Four of the coal-tar colours differ from the rest of their class as regards stability, *i.e.*, the ponceau called naphthol carmine, orange No. 2, chrysoine, and artificial alizarin.

Colours for painting in water and in oils are divided into the absolutely permanent, the moderately permanent, and the fugitive. If used with water all the most beautiful reds, carmine, carmine-lake, most madder lakes, and vermilion, fall under the fugitive class. If mixed with oil the madder lakes rank as moderately permanent.

The action of the arc light is similar to that of the sun, but has only one-fourth of the power.—*Bulletin de la Société d' Encouragement.*

DETERMINATION OF THE TANNIN IN VEGETABLE PRODUCTS, AND ESPECIALLY IN THE BARKS OF THE OAK, BIRCH, FIR, QUEBRACHO, CINCHONA, IN DIVIDIVI, GALLS, &c.

By M. PERRET.

I. For barks of certain kinds 20 grms. are sufficient for the determination. In other cases it is necessary to operate upon 100 grms. freed from moisture, the loss being taken into account in calculating the results.

II. The substance taken, of whatever kind, is submitted to two successive boilings of 15 minutes each with distilled water. The two liquids are poured together into a porcelain capsule and evaporated down to 100 c.c. The liquid must be boiling and clear, having been filtered. It is then let cool down to 70° and there is added by degrees, but within the time of two miuutes and with constant stirring, a solution of dried egg-albumen, standardised to one-fifth, as long as a precipitate is formed. The heat is kept up without regarding any excess of albumen which may have been employed, and is raised to 100°; the liquid thus freed from tannin passes in bubbles through the mass, which is almost colourless.

III. At this moment there is added from a Mohr's burette, a decinormal solution of dry aluminium sulphate until the deposit, which was previously of a spongy texture, becomes compact and granular and separates from the mother-liquor. It is let cool, and brought upon a tared filter. The precipitate is washed with hot water and dried in the stove upon a cake of plaster.

IV. When the weight has become constant there are deducted from it the weights of the filter, of the albumen, and of the sulphate of alumina corresponding to the number of c.c. of these solutions actually employed. The difference then gives the weight of the active tannin contained in the substance under examination.

V. The standard decinormal solution of aluminium sulphate is made by dissolving 10 grms. of the dry sulphate so as to make up 100 c.c. of a solution, unfiltered.

VI. The solution of egg-albumen is obtained by dissolving 20 grms. of the dry egg-albumen of commerce in distilled water sufficient to make up 100 c.c. of an unfiltered solution.

The author asks what becomes of the sulphuric acid in the aluminium sulphate, but he adds that it disappears absolutely before the fact. The solution at the strength chosen is said to have been found by experience to saturate the tannate of albumen perfectly and convert it into a lake, and "the sulphuric acid, whilst decomposing the calcium, magnesium, &c., tannates, increases exactly by its own weight the quantity of tannin deposited."—*Bulletin de la Soc. Chimique de Paris.*

[There are other elements of doubt attached to this process.—*Ed.* C. N.].

SOME CONVENIENT QUANTITATIVE LECTURE APPARATUS.

By ARTHUR MICHAEL.

The need felt by teachers of chemistry not only to present to their hearers the principal facts of their science qualitatively, but also quantitatively, has been the cause of what may be called an evolution in lecture apparatus. This has culminated in instruments, notably by Bunsen and A. W. Hofmann, which are hardly open to improvement as far as simplicity combined with accuracy are concerned. Their deficiency is more in expensiveness, and, especially in regard to Hofmann's apparatus, fragility. In this note some quantitative lecture apparatus will be described, which were devised with the special view of combining sufficient accuracy with stability and cheapness. It is becoming more and more desirable that all students of chemistry should convince themselves of the truth of the most important reactions, and the composition of some of the principal inorganic compounds, from personal observation, and apparatus has become imperative which can be made by anyone having a slight experience in glass-blowing. The aid that a knowledge of glass-blowing affords to a scientific chemist cannot be over estimated. The writer is convinced that a training in it should never be omitted from the course required of students making chemistry their profession.

The trough used is Liebig's well-known instrument slightly modified. Liebig's trough has notably two defects. The eudiometer after the explosion is apt to bump, which often causes an overflow of mercury, and even at times breaking the apparatus. This is remedied by placing a rubber plug on the bottom of the trough, and

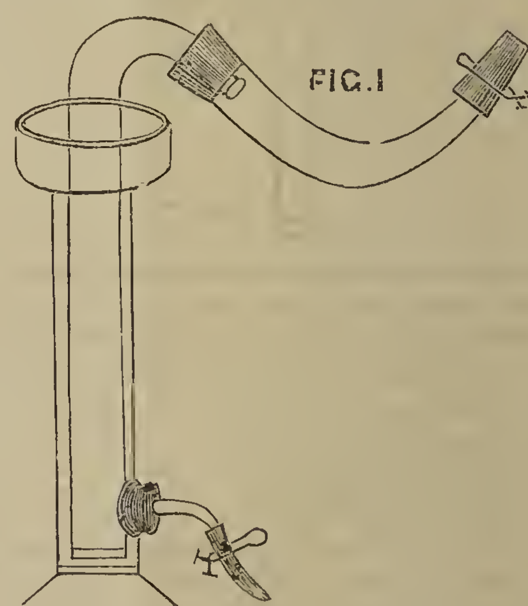


FIG. I

holding the eudiometer firmly down on it by means of a retort-clamp. A second defect is in the difficulty of emptying, or adjusting the height of the mercury, even when it does not contain a eudiometer. To obviate this inconvenience a tubulus is brought on the narrow part of the trough, an inch or two above the foot, and fitting into it a cork with a tube bent at right angles and ending in a piece of rubber tubing and spring-clamp* (Fig. 1). The cup of the trough should be three or four inches in diameter, while the narrow part need not be much wider than the largest eudiometer in use. These additions, as slight as they may seem, quite change the apparatus in respect to convenience and handiness.

The eudiometers should be several inches higher than the trough, and may be conveniently divided by calibra-

* A hole drilled by means of a diamond and fitted with a cork and tube will answer the purpose.

tion into twelve equal divisions. In order to render the readings noticeable from a distance, rings of dark rubber are placed over each division. A rubber band, about one-half inch in width, brought over the open end of the eudiometer, will be found to render it less liable to breakage, and is also of use in indicating the proximity of the open end to the surface of the mercury. To obviate the necessity of lowering the eudiometer a number of times while introducing a given volume of gas, it has been found desirable that each instrument should have a second calibration, which is made by introducing successively a unit volume of air, when the eudiometer is held upright, with the upper end of the broad rubber band level with the mercury in the trough. The results are marked in half lines across the instrument, with the number of unit volumes.

In the analysis of gases requiring an absorption of part of the products formed by the explosion a modified eudiometer is used, which obviates the introduction of liquid reagents. The instrument ends in a tube bent in the form of a half-circle, and connected by a rubber tube with a small bulb (Fig. 2). After the explosion, the communication between the eudiometer and the bulb containing the absorption-liquid is opened, and the eudiometer sunk to the bottom of the trough. Owing to the gases being under pressure, the absorption takes place quite rapidly, and is generally finished in one-half to three-quarters of an hour, when the spring-clamp is closed and a second reading taken. The instrument has the further advantage of permitting the examination of the absorption-liquid.

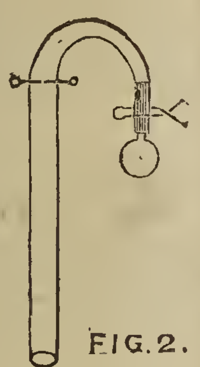


FIG. 2.

Bunsen* has devised a very ingenious apparatus for the purpose of ascertaining the composition of certain oxides by measuring the volume of oxygen used in oxidising a known weight of the element. The following apparatus involves the principle of Bunsen's, but is much more compendious and needs less mercury, without a very great loss in the accuracy of the results. A tube about an inch longer than the trough is graduated, beginning an inch and a half from the upper end, into about 160 to 180 parts of 1 c.c. each. The upper end of the measuring-tube is joined to a tube about three-fourths of its diameter, and bent to form an angle of 45°. This tube is connected by a rubber cork with a curved tube of difficultly fusible combustion tubing, which is drawn out at the other end to a small tube, and closed by a piece of tubing and spring-clamp (Fig. 1).

In the analysis of sulphur and carbon dioxides, when the volmme of the gas after the combustion remains unchanged, the apparatus is about half filled with oxygen. This is done by connecting the open end of the heating-tube with an oxygen generator, displacing the air, then the measuring-tube brought under mercury to 100 c.c., the generator disconnected, and the heating-tube closed. By heating the carbon or sulphur, which is previously placed in the heating-tube—the first, to prevent the tube from cracking on a piece of platinum foil, the latter on a chip of glass—a vivid combustion takes place, which can be seen from a distance. In the analyses of oxides, when the volume after combustion is less then the volume of oxygen taken, the measuring-tube is filled with oxygen to about 20 c.c. from the open end, and a quantity of the element used which requires from 100 to 120 c.c. of oxygen for its combustion. Before heating the substance, the measuring-tube is firmly placed on the rubber plug of the trough, which is then filled with mercury. The results obtained in the analyses of phosphorus pentoxide,* arsenic trioxide, magnesium oxide, &c., are sufficiently accurate to prove the constitution of these compounds beyond a doubt.

Bunsen's apparatus has hitherto only been used in ascertaining the volume of oxygen required for the combustion of certain elements. The above-described apparatus, or a slight modification of it, can be used for ascertaining the composition of a large number of important inorganic compounds, by measuring the volume of gas evolved in the decomposition of a known weight.

In studying quantitatively the decomposition of a substance, potassium chlorate for instance, by heat, a weight, of it which will give off about 120 c.c. of gas is placed on a small platinum boat and brought into the heating-tube. After the mercury is adjusted opposite the zero mark, the substance is heated by a Bunsen burner until the volume of gas in the measuring-tube remains constant, when, after cooling, a second reading will give the volume of gas evolved in the reaction.†

For the purpose of estimating the volume of a gas given off in a wet reaction, the heating-tube is replaced by a small flask of a capacity of 20 to 30 c.c., and connected by a tube, attached to the neck and bent at right angles, to a

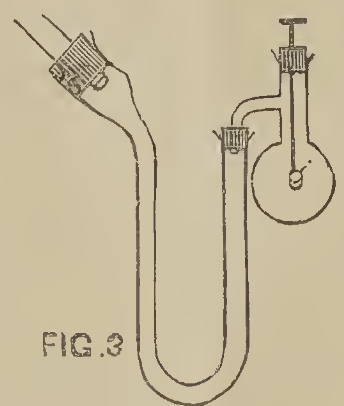


FIG. 3

drying tube. Through a rubber cork in the flask, a glass rod bearing a small perforated platinum basket and marked when the basket is in the upper part of the flask, is brought, and the rod greased that it may be freely moved in the cork. The drying tube is filled with calcium chloride, and connected by a rubber cork with the measuring-tube (Fig. 3). If the gas is soluble in the liquid used for decomposition, the flask is replaced by a small test-tube, on which a mark is brought showing that two or three c.c. of the liquid are used, and a correction made for solubility. For analysis the flask is half filled with the liquid, the glass rod pressed down until the mark is in contact with the upper end of the cork; and after the volume of air in the measuring-tube is read, the basket, containing a weighed quantity of the substance, is brought under the liquid. After the reaction is over the rod is brought back to the original position, and from a second reading the volume of gas evolved is ascertained.

I have not entered into the details of handling the apparatus, because they do not essentially differ from those

* See Heumann, "Anleitung zum Experimentiren bei Vorlesungen uber anorganische Chemie," 52.

* Amorphous phosphorus must, of course, be used in this experiment, The commercial product leaves an ash, which is insoluble in water. It is therefore necessary to purify it, or determine the ash and make the required correction.

† It is well to add a trace of platinum black in the analysis of $KClO_3$. A much smaller heating-tube closed at one end, and the bent open and fitted into the measuring-tube, is advantageously used in such pyro-analyses. That the measuring-tube and trough can be replaced by an apparatus constructed on the U tube principle is evident.

necessary in using an ordinary eudiometer. Before each reading, the mercury in and outside the measuring-tube is brought to a level, and barometric and thermal observations are, of course, necessary. It is evident that three classes of reactions may be quantitatively examined by means of the apparatus. Firstly, those depending on a volume of oxygen absorbed;* secondly, those in which a gas is evolved at the temperature under a red heat; and, finally, those reactions in which a gas is evolved in the action of a liquid on a solid. The important reactions which can be examined in the apparatus are so numerous that its range is hardly exceeded by any other lecture apparatus. In most cases the complete analysis may be realised in a few moments by a volumetric analysis of the product remaining in the heating-tube or decomposition flask. Thus, in the analysis of potassium chlorate, the chloride remaining in the heating-tube can be washed into a beaker and a volumetric chloride estimation made; or, in the investigation of the action of chlorhydric acid on metallic zinc or calcium carbonate, a known volume of standard acid taken and the undecomposed acid determined by titration.

It is often desirable to keep a small volume of a gas for subsequent investigation—a purpose for which the following simple gasometer has been found useful:—Two small bottles of about 50 c.c. each, are fitted with double-bored rubber corks, and connected by a glass tube bent in the form of a syphon. The limb of the syphon, which is in the flask used as gasometer, is somewhat longer than the other limb. Through the second hole of that bottle a bent delivery tube, provided with a small glass stopcock, barely passes, and a small bent tube passes through the cork of the second bottle. For use, the gasometer and syphon are filled with mercury, and the end of the delivery tube then connected with the generating flask.† A small quantity of mercury is allowed to remain in the gasometer. The apparatus works, to a certain extent, automatically. On opening the stopcock of the charged gasometer, mercury will pass over until it is on a level in both bottles, and the remaining half can be expelled by applying pressure to the bent tube of the second bottle. A well-constructed apparatus will keep a gas for weeks without an appreciable change.

I wish finally to call attention to a slight modification of Hofmann's well-known V tube, which permits the collection of both the products of decomposition, and can, therefore, be used for quantitative analysis. On the upper side of the bend of the tube a glass tube is connected, which is an inch higher than the limbs of the V tube (Fig. 4). The limbs are graduated in five or six equal parts;

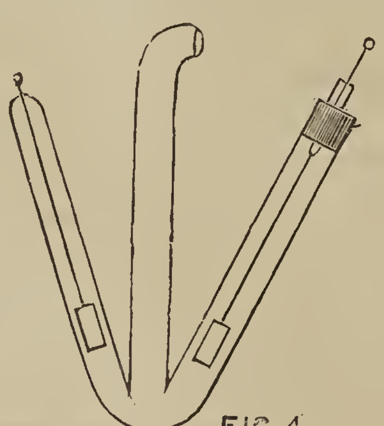


FIG. 4

those on the open limb beginning, not at the open end, but about one half an inch from it. For use, the apparatus is filled with liquid, and the cork, through which a glass tube with platinum electrode passes, is pressed into the open limb until it reaches the first graduation. The displaced liquid flows out through the middle limb, which is conveniently connected with a rubber tube. Ungraduated Ure's eudiometers, provided with a short horizontal tube on the lower side of the bend, or on the upper side and bent downwards, make a cheap and efficient substitute for Hofmann's lecture-eudiometer, especially for students' use in the laboratory.—*American Chemical Journal*, vol., v., No. 5.

* No experiments have been made as yet on reduction of heavy metallic oxides in hydrogen, under similar conditions; but I do not doubt that sufficiently accurate results would be obtained.

† A more advantageous form is to have the delivery tube connected to the neck of the gasometer, directly under the rubber cork.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

MANGANESE.

Rejecting the early experiments of J. Davy and of Arfvedson, the first determinations of the atomic weight of manganese which we encounter are those of Turner† and of Berzelius.‡ Both of these chemists used the same method. The chloride of manganese was fused in a current of dry hydrochloric acid, and subsequently precipitated with a solution of silver. From the subjoined weighings I calculate the ratio given in the third column between $MnCl_2$ and 100 parts of AgCl:—

		Berzelius.
4·20775 grms. $MnCl_2$	= 9·575 grms. AgCl.	43·945
3·063 ,,	= 6·96912 ,,	43·950
		Turner.
12·47 grains $MnCl_2$	= 28·42 grains AgCl.	43·878
	Mean	43·924 ± 0·015

Hence the molecular weight of $MnCl_2$ is 125·662 ± 0·045.

Many years later Dumas‖ also made the chloride of manganese the starting point of some atomic weight determinations. The salt was fused in a current of hydrochloric acid, and afterwards titrated with a standard solution of silver in the usual way. 100 parts of Ag are equivalent to the quantities of $MnCl_2$ given in the third column:—

3·3672 grms. $MnCl_2$	= 5·774 grms. Ag.	58·317
3·0872 ,,	5·293 ,,	58·326
2·9671 ,,	5·0875 ,,	58·321
1·1244 ,,	1·928 ,,	58·320
1·3134 ,,	2·251 ,,	58·321
	Mean	58·321 ± 0·001

Hence $MnCl_2$ = 125·594 ± 0·011. This, combined with Berzelius and Turner's figures, gives $MnCl_2$ = 125·598 ± 0·011. And Mn = 54·858 ± 0·031.

An entirely different method of investigation was followed by v. Hauer,§ who, as in the case of cadmium, ignited the sulphate in a stream of sulphuretted hydrogen, and determined the quantity of sulphide thus formed. I subjoin his weighings, and also the percentage of MnS in $MnSO_4$ as calculated from them. (See Table next column).

This method of v. Hauer's, which seemed to give good results with cadmium, is, according to Schneider,¶ inapplicable to manganese; for the reason that the sulphide of the latter metal is liable to be contaminated with traces of oxysulphide. Such an impurity would bring the atomic weight out too high. The results of two different

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Trans. Roy. Soc. Edin.*, 11, 143. 1831.

‡ "Lehrbuch," 5th Ed., 3, 1224

‖ *Ann. Chem. Pharm.*, 113, 25. 1860.

§ *Journ. f. Prakt. Chem.*, 72, 360. 1857.

¶ *Poggend. Annal.*, 107, 605.

4·0626 grms. $MnSO_4$ gave	2·3425 MnS.	57·660 per cent.	
4·9367 ,,	2·8442 ,,	57·613 ,,	
5·2372 ,,	3·0192 ,,	57·649 ,,	
7·0047 ,,	4·0347 ,,	57·600 ,,	
4·9175 ,,	2·8297 ,,	57·543 ,,	
4·8546 ,,	2·7955 ,,	57·585 ,,	
4·9978 ,,	2·8799 ,,	57·625 ,,	
4·6737 ,,	2·6934 ,,	57·629 ,,	
4·7240 ,,	2·7197 ,,	57·572 ,,	
		Mean 57·608 $\pm$ 0·008	

Hence Mn = 54·785 $\pm$ 0·031.

processes, one carried out by himself and the other in his laboratory by Rawack, are given by Schneider in this paper.

Rawack reduced manganoso-manganic oxide to manganous oxide by ignition in a stream of hydrogen, and weighed the water thus formed. From his weighings I get the values in the third column, which represent the Mn_3O_4 equivalent to 1 grm. of water:—

4·149 grms. Mn_3O_4 gave	0·330 H_2O.	12·5727
4·649 ,,	0·370 ,,	12·5643
6·8865 ,,	0·5485 ,,	12·5552
7·356 ,,	0·5855 ,,	12·5636
8·9445 ,,	0·7135 ,,	12·5361
11·584 ,,	0·9225 ,,	12·5572
		Mean 12·5582 $\pm$ 0·0034

Hence Mn = 53·911 $\pm$ 0·026.

Here the most obvious source of error lies in the possible loss of water. Such a loss, however, would increase the apparent atomic weight of manganese; but we see that the value found is much lower than that obtained either by Dumas or v. Hauer.

Schneider himself effected the combustion of manganous oxalate with oxide of copper. The salt was not absolutely dry, so that it was necessary to collect both water and carbon dioxide. Then, upon deducting the weight of water from that of the original material, the weight of anhydrous oxalate was easily ascertained. Subtracting from this the CO_2, we get the weight of Mn. If we put CO_2 = 100, the quantities of manganese equivalent to it will be found in the last column:—

Grms.	Grms.	Grms.	
1·5075 oxalate gave	0·306 H_2O and	0·7445 CO_2.	61·3835
2·253 ,,	0·4555 ,,	1·1135 ,,	61·4291
3·1935 ,,	0·652 ,,	1·5745 ,,	61·4163
5·073 ,,	1·028 ,,	2·507 ,,	61·3482
			Mean 61·3943 $\pm$ 0·0122

Hence Mn = 53·904 $\pm$ 0·014.

This result agrees beautifully with the value calculated from Rawack's experiments.

Now to combine the four independent values which we have thus far obtained:—

From $MnCl_2$	Mn =	54·858 $\pm$	0·031
,, $MnSO_4$	,,	54·785	0·031
,, Mn_3O_4	,,	53·911	0·026
,, MnC_2O_4	,,	53·904	0·014
General mean ..	,,	54·128	0·011
If O = 16	,,	54·251	

The considerations already cited, however, go to show that this general mean must be slightly affected by some plus constant error. It is probable, therefore, that a more correct figure will result from rejecting the first and second values in the above combination, and taking the data furnished by Rawack and Schneider alone. Combining their figures we get as follows. Mn = 53·906 $\pm$ 0·012. Or, if O = 16, Mn = 54·029.

Since the foregoing calculations were made Dewar and Scott* have reported the following experiments. From the complete analysis of silver permanganate, putting Ag = 108 and O = 16, they find in three estimations Mn = 55·51, 54·04, and 54·45. From the analysis of pure MnO_2, made from the nitrate, Mn = 53·3 to 53·6. Up to the date of writing a detailed account of the methods employed has not been published.

The following additional note has been communicated by the author:—

Since the foregoing was printed, new determinations of the atomic weight of manganese have been made by Marignac,† and the details of Dewar and Scott's work have appeared.‡

Dewar and Scott, without reporting particulars, state that experiments upon $MnCl_2$ give a value for Mn of 54·91 and others upon $MnBr_2$ make Mn = 54·97. Six reductions of $AgMnO_4$, by heating in hydrogen, give in mean a residue of Ag + MnO, equal to 78·835 per cent, $\pm$ 0·017. Hence Mn = 54·968 $\pm$ 0·497. Ten titrations of $AgMnO_4$ with KBr give in mean 190·647 $\pm$ 0·114 part of the former salt as equivalent to 100 of the latter. Hence, recalculated, Mn = 54·936 $\pm$ 0·143.

Marignac, by converting pure MnO into pure $MnSO_4$, found 100 parts of the former equivalent to 212·73 $\pm$ 0·0279 of the latter. Hence Mn = 54·891 $\pm$ 0·0228.

The foregoing results, combined with the results of Dumas, Berzelius, Turner, and v. Hauer, give a general mean of Mn = 54·855 $\pm$ 0·016. If O = 16, this becomes Mn = 54·981. The higher value for manganese may now be considered established.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, January 26, 1884.

Prof. CLIFTON, President, in the Chair.

NEW Member—Fung Yee, Secretary to the Chinese Legation.

Prof. CLIFTON announced that Lady Siemens had presented a portion of the late Sir William Siemens's library to the Society.

The meeting, which was at first a special meeting to consider the resolution that it is expedient for the Past Presidents of the Society to be permanent Vice-Presidents, having agreed to this resolution, was constituted an ordinary meeting, and

Profs. AYRTON and PERRY described and exhibited their new ammeters and voltmeters, also a non-sparking key. The well-known ammeters and voltmeters of the authors used for electric light work are now constructed so as to dispense with a constant and give the readings in Ampères and Volts without calculation. This is effected by constructing the instruments so that there is a falling off in the controlling magnetic field, and a considerable increase in the deflecting magnetic field. The deflections are thus made proportional to the current or E.M.F. measured. The ingenious device of a core or soft iron pole-piece, adjustible between the poles of the horse-shoe magnet, is used for this purpose. By means of an ammeter and voltmeter used conjointly, the resistance of part of the circuit, say a lamp or heated wire, can be got by Ohm's law. Profs. Ayrton and Perry's non-sparking key is designed to prevent sparking with large currents. It acts by introducing a series of resistance coils determined experimentally one after the other in circuit, thereby cutting off the spark.

* *Nature*, Sept. 15, 1881, p. 470.
† *Arch. des Sci. Phys. et Nat.*, (3), 10, 21.
‡ CHEMICAL NEWS, xlvii., 98.

Dr. C. R. Alder Wright, F.R.S., read a paper on the "*Electromotive Force set up during Inter-diffusion*," being the result of experiments made by himself and Mr. C. Thompson, to determine the effect of varying densities of solutions used in voltaic cells on their E.M.F.s. The observations were made by constructing the cells of pure materials and opposing them, so that the differential E.M.F.s could be measured by galvanometer or quadrant electrometer, when solutions of different densities were employed. The following general conclusions were reached:—(1) In any two-fluid cell containing solutions of two metallic salts and plates of the respective metals contained therein, an increase of strength in the solution surrounding the plate acquiring the higher potential, in virtue of the normal action of the cell, causes an increment in the potential difference between the two plates: and the opposite effect is produced by an increment in the strength of the solution surrounding the other plate. (2) A law of summation holds, expressible thus: The effect of the sum of a series of changes in the strengths of the solutions in a two-fluid cell is equal to the algebraic sum of the effects of each change severally. The author considered this law very fully, and pointed out that "diffusion cells" act at least partly after the fashion of thermo-couples, transforming into electric energy a certain amount of sensible heat.

NOTICES OF BOOKS.

Principles of Theoretical Chemistry, with special reference to the Constitution of Chemical Compounds. By Ira Remsen, Professor of Chemistry in the Johns Hopkins University. Philadelphia: Henry C. Lea's, Son, and Co., 1883 (2nd Edition).

To Professor Remsen every conscientious student of chemistry must feel himself indebted for the care and labour which the author has given to the writing of this little manual and the impartial manner in which the principles of the science are treated. After cramming into one's head heaps of formulæ and equations, hypotheses rigidly stereotyped with every care to make them look like laws, one experiences a sense of relief on taking up this book and following the author's discussions of the principal hypotheses which are at present considered as the foundation stones of the science of chemistry. How very few students take the trouble to reason out for themselves the exact connections between facts and hypotheses, and the readiness with which they accept hypotheses without fully recognising the facts upon which they are based every teacher knows too well, and it is, therefore, highly necessary that for the sake of such students a work of the present character should be written in order to show how much we do not know, and upon how very narrow a foundation the hypotheses of the science rest. In his preface the author tells us that his object has been to point out the exact connection between the facts known to us and the hypotheses, and in the same place he only reiterates the experience of other teachers but too truly when he says that "Much harm has been done the science by a too free use of hypotheses by those who were ignorant of the facts which suggest them. This has been and is particularly noticeable in connection with the use of structural or constitutional formulas. It is heart-rending to see a tyro in chemistry using these formulas with a freedom that might well appal one who knows their true meaning. An experience of years with students of chemistry has led me to the conclusion that the formulas are generally used without understanding." This state of affairs it might be urged must be due to the teachers themselves or more justly to the writers of our text-books who follow one general plan of a mere statement of facts and embellish their works with multitudinous formulæ, leaving it to the student himself to co-ordinate the facts with the hypotheses.

Treatises like the one now before us, which discuss the hypotheses in chemical science, already exist, such, for instance, as the excellent work of Lother Meyer; but so far as our experience goes none of them are so admirably suited to the student in his earlier stages of instruction as serving to keep him in check in his reckless acceptance of hypotheses, and for training him to think of the facts in relation to the hypotheses which may lead him to see that the aim and end of all chemistry is not the determination of a formula or equation or the compound formed by the action of x upon y, but that beyond these things—almost trivialities now—there are far higher matters in the science which demand investigation.

It is needless for us to give a detailed account of the contents of Prof. Remsen's little book, as all the principal hypotheses in the science are discussed in an impartial manner and as objectively as possible, and the arrangement and style of the matter all that could be desired. In the first part we have a general discussion of atoms and molecules; the three first chapters of this section being upon the atomic hypothesis, atomic weights, how these values are determined in relation to each other, the bearing of Gay-Lussac's investigations and Avogadro's speculations upon the subject, and the facts obtained by the study of the specific heats of the elements in connection with atomic weights. Then follow two chapters, one on the properties of the elements as functions of their atomic weights in which Mendelejeff's and Meyer's arrangements into periods are discussed, and the other on valence or atomicity of the elements in which the subject is considered from all points. In the second part, on the constitution or structure of chemical compounds, this wide field is gone over with considerable minuteness, and is certainly a valuable section for the student of the present period,—"a period of chemistry which may be fairly called one of formula worship,"—who is so apt to look upon a formula of a compound as representing its internal structure or mode of arrangement of its contained elements, as showing by the proofs that are brought forward in support of the formulæ upon what slender grounds they rest. "A study of the preceding chapters on constitution will show that no absolute meaning is to be attached to the word. Constitutional formulas are those which suggest certain reactions and recall analogies. The formula suggests possibilities; it may not represent realities."

As an exposition of the hypotheses in use in chemistry this little book is sure to take a high rank, and we cannot but think that its study, in conjunction with one of the usual text-books of facts, by the elementary student, would prove of very great service to him, and would also be of assistance to those teachers who lay so much stress upon the value of formulæ for purposes other than as aids to the memory.

The Year-Book of Photography for 1884. Edited by H. Baden Pritchard, F.C.S. London: Piper and Carter.

We have here what might be well termed the photographer's "Whitaker" for the year 1884, which, containing a complete calendar for the year, notices of the various photographic societies throughout the country, and the principal ones on the continent and in America, together with a heap of information such as every photographer requires, hints on developing, printing, lighting, and posing, and numberless other subjects, forms a complete epitome of the present state of photography. It would be beyond our scope to give even the merest outline of the contents of this almanac, or name the well-known authorities who have helped to produce this work under the able editorship of Mr. Pritchard, but suffice it to say that no one will take up the volume without gaining some information or hint that may be of service to him.

Together with a retrospect of the photographic progress made during the year that has just passed away, a number

of contributions that will prove of use both to amateurs as well as to professionals, and many pages of instructive and amusing jottings from the pen of the editor, a portion of the book is devoted to standard formulæ with short descriptions for working the preparations; tables for the conversion of grammes into ounces and grains, and a short epitome of qualitative chemical analysis sufficient to suit the purposes of the photographer.

Considering the large amount of valuable information that has been compressed into this little book we think no photographic studio could be considered complete without a copy.

The Extra Pharmacopœia of Unofficial Drugs. By William Martindale, F.C.S., and W. W. Westcott, M B. Lond. Second Edition. London: H. K. Lewis, 1884.

In a neat and handy little volume we have here a valuable dictionary of unofficial drugs and chemical and pharmaceutical preparations. Considering that it is about sixteen years since the publication of the last British pharmacopœia and the progress that has been made in medical science by the introduction of many valuable new drugs and methods of treatment during this interval, there are sufficient reasons for the publication of this extra pharmacopœia. These new drugs, their uses, and the doses employed are described in this little manual, viewed specially from a pharmaceutical and medical aspect, abundant references being given to the original sources of the information. The usual system of weights is employed throughout of ounces, grains, drachms, &c., although the author thinks rightly that much advantage would be derived by the introduction of the metric system into pharmacy. With a very copious index and posological table of the contents, together with a therapeutic index of diseases and symptoms, this little book cannot fail to be of much service to the profession. The fact that the first edition was exhausted in a few weeks says much for the quality of the compilation and the desirability of such a dictionary among medical men.

The Chemical Effect of the Spectrum. By Dr. J. M. Eder, Professor at the Technische Hochschule, Vienna. Translated and Edited by Captain W. de W. Abney, R.E., F.R.S. London: Harrison and Sons, 1883.

Looking back over the last 60 years since the days when Nièpce was quietly working out his plans for drawing pictures by light and struggling to bring his invention before the notice of the public, and considering the beautifully artistic productions that are now to be had for a few pence, one cannot help admiring the wonderful amount of labour that has been expended and the skill that has been brought to bear upon the subject. Empirical experimentation, and much of it, has been the source of all the success of the photograpic student, and a glance through this pamphlet shows but a fraction of the vast amount of labour that has been expended in bringing up Nièpce's first crude method of photography to the perfection it has now obtained. Dr. Eder's small book has already appeared in English in the *Photographic Journal* for 1881 and 1882, translated from the French copy, and from which journal the present is a reprint. It is certainly desirable, however, that the work should be published in a separate form, as its principal value depends on its excellency as a book of reference to the experimental work of others. As the title of the pamphlet indicates, the contents treat in the main of the action of light on chemical compounds, as the salt of silver, iron, uranium, &c., sensitisers and dyed films, in which the results obtained by different experimenters are given with references to their publications, which will render the book a valuable addition to photographic literature.

It might have been well, we think, to have given a fuller index with the names of the workers whose observations are quoted in the body of the book, as for a work of reference this is certainly desirable.

CORRESPONDENCE.

RAPID FILTRATION.

To the Editor of the Chemical News.

Sir,—I have devised a more simple means for inducing rapid filtration in analytical work than any I have yet seen mentioned.

The filter is prepared, and supported at the point by a cone, as required by the suction methods, in a funnel, which it is best to have with its edges ground level, and held in any firm support.

The device is simply to have a glass plate about 6 inches in diameter and 1 inch thick, which has a $\frac{1}{4}$-inch thick soft rubber disc of the same size as the glass cemented to its surface. There is a hole through the centre of the glass and rubber plate. This heavy plate is large enough to cover any size funnel likely to be used, and will make a tight joint by its rubber side with the funnel, either through its own weight or if pressed down by the hand. Through its central hole air is forced in from a rubber tube connected with one of Fletcher's excellent foot-bellows, to *any* desired pressure. To prevent the air thus blown in from agitating too much the fluid contents of the filter, a piece of very thin sheet rubber, something larger square than the hole, is fastened over it by its four corners, having pins passed slantingly through them into the rubber plate beneath it. This prevents the air from being blown straight down into the filter, but makes it spread out sideways.

This method leaves free and easy access to both the filtrate and the filter by the simple lifting off of the plate from the funnel, is simple of application, and not likely to be out of working order when wanted for use. The pressure is under perfect control.—I am, &c.,

B. F. Davenport, State Analyst.

Boston, Mass., Jan. 9, 1884.

VOLUMETRIC ESTIMATION OF MANGANESE.

To the Editor of the Chemical News.

Sir,—I am very glad to see that the method mentioned by me in the Chemical News, vol. xlix., p. 9, is used in other laboratories, and is found to work well; I should not have called attention to such a simple matter, but that no one I consulted knew of that particular method being in use elsewhere. I do not, however, prefer Mr. Atkinson's method (vol. xlix., p. 25) of estimating the silicon to the one we use; and it surprises me to hear he finds the least difficulty in filtering the solution of Mn and Fe from the insoluble SiO_2. We have none whatever, as, if one is doing six at once, the first is through the filter before the sixth can be got into the funnel. Neither does any Fe_2Cl_6, which is always formed, make any difference. We wash with hot water containing about 5 per cent HCl, and find our silica quite white and free from iron. We are the happy possessors of a good stink-cupboard, and as the HCl is evaporated in it the fumes cause no annoyance; but would not Mr. Atkinson prefer HCl vapour to H_2SO_4 vapour, if you *must* have one or the other? I should.

However, we will try the sulphuric acid method practically, and if we find any improvement on our present ways, either in time or accuracy, it will be adopted, as I am always very glad to learn.—I am, &c.,

A. H. Holdich.

Wigan Coal and Iron Co,
Jan. 21, 1884.

ON THE DETECTION OF ALBUMEN IN URINE.

To the Editor of the Chemical News.

Sir,—In the letter of Prof. Mason, of Troy, New York, which appeared in the Chemical News, vol. xlviii., p. 304, he suggests that, as the acetic acid which I use cannot prevent the precipitation of phosphate of iron, the test is therefore useless for detecting albumen in urine.

Since my letter appeared, I have gone over the subject again with identically the same results.

If Prof. Mason will experiment with a 2 per cent solution of sodium phosphate (from 2-3rds to 3-4ths the P_2O_5 in urine is combined with either Na or K), to which he will add a saturated solution of sodium chloride, he will find that a white precipitate will form; on the addition of acetic acid this will re-dissolve. If to this solution he adds an acid Fe_2Cl_6 solution no visible precipitate will be formed till after the lapse of at least two hours, and if the sodium phosphate solution be still more dilute it may not become visible before twelve hours (see "Fresenius's Qualitative Analysis," pp. 154, 155); while, on the other hand, albumen will be precipitated almost immediately. Prof. Mason is correct in stating that acetic acid will not prevent the ultimate precipitation of phosphate of iron, but it retards it sufficiently for practical purposes.—I am, &c.,

A. R. Haslam.

Dublin, January 22, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chemie.
Tome viii., December, 1883.

A New Process for the Determination of Cinchonas.—A. Petit.—Prollius has shown that on treating 40 grms. of cinchona bark with 800 grms. of a liquid composed of—

Alcohol at 95°	67 parts,
Sulphuric ether at 65°	733 "

to which are added 32 grms. of ammonia, and shaking the whole up together, all the alkaloids of the bark are easily brought into solution. Comparative trials have shown that the bark must be finely powdered, and that by shaking every five minutes the exhaustion is as complete in an hour as after maceration for five or six hours. 600 grms. of the liquid are decanted, which represent three-fourths of the bases of the portion operated upon, or in other words the bases present in 30 grms. of the sample. There is then added a solution containing one-fourth of its weight of sulphuric acid, and in such a quantity that the aqueous liquid which separates may be distinctly acid. In general 22 c.c. are sufficient. This aqueous liquid contains all the alkaloids previously contained in the ethereal solution, and is decanted off by means of a special funnel. The ethereal liquid is again shaken up with 5 c.c. of acid and 15 c.c. of water, the aqueous solution being then decanted, and added to the former quantity. This liquid is then heated in the water-bath to expel dissolved ether, diluted with twice its volume of water, and precipitated with an excess of caustic soda. On stirring with a glass rod and heating slightly in the water-bath,—if necessary—the alkaloids collect together in a mass, which is placed in a stove and dried at 100°. If the liquid is not absolutely clear it is filtered through a tared filter, and the difference of weight is added to that of the alkaloids which have collected in a mass. We have thus the total weight of the alkaloids contained in 30 grms. of the sample. They are then dissolved in a slight excess of sulphuric acid, and there are added 25 c.c. of ether at 65°, and 5 c.c. of ammonia, and the whole is shaken up. The alkalies soluble in ether dissolve in that liquid, and are removed by decantation. The original solution is again shaken up with 10 c.c. of fresh ether, which is then decanted off, and added to the former quantity. After being let stand for fifteen minutes, so that the alkaloids which are sparingly soluble in ether may be deposited, it is then decanted, and agitated with 10 c.c. of water containing 5 per cent of sulphuric acid, and again, after separation, with 5 c.c. of the same acid. These two liquids are poured together, and it is ascertained that they are distinctly acid. The liquid is made up to 25 c.c., saturated with ammonia diluted to one-fifth, and raised to a boil. When the reaction is very feebly alkaline the heat is withdrawn. Quinine sulphate then separates out in the form of fine crystalline needles. When completely cold they are collected on a tared filter, washed with a solution of quinine sulphate (saturated in the cold), and dried in the stove at 100°; drying until the weight becomes constant. From the dry quinine sulphate thus obtained from 30 grms. the proportion of hydrated sulphate corresponding to 1 kilo. is calculated. In order to ascertain if the quinine sulphate is sufficiently pure it is dissolved in sulphuric acid, and the solution is examined with the polariscope. If the rotatory power does not approach sufficiently near to −238·3° for the ray D, and the temperature 15°, it is purified by a new treatment with ether and ammonia, and by a second crystallisation.

Poisoning with Chromic Acid.—M. Lacassagne.—An account of the death of two men who had swallowed a wine glass full of an acidulated solution of potassium dichromate used for supplying a "Grenet" battery, and which from its colour they had mistaken for Malaga wine. The two together seem to have swallowed about 5 grms. of the dichromate.

Examination of Spots produced by the Washings of a Gun recently used.—M. Masse.—An Arab, suspected of having fired at and wounded one of his relatives, accounted for certain black spots found on a linen cloth in his possession as having been caused by mulberry stains. The spots were not removed by cold water, and under the microscope they appeared to consist of small black irregular grains. On the other hand, mulberry stains gave a violet colour to cold water, and on microscopic examination showed vegetable cellules containing a violet matter, and granules of chlorophyll. Hence the experts decided that the stains on the garment of the accused could not have been produced by the juice of fruits.

Detection of Methylic Alcohol in Ethylic Alcohol.—E. van de Vivère.—The author distils the suspected matter in the water-bath, heating as long as volatile products pass over. These are again distilled in the water-bath over pure dry sodium carbonate, so as to obtain the alcohols in the anhydrous state. The volume of the mixture is then taken. In one portion the presence of methylic alcohol is ascertained. The other part is weighed, and mixed with an equal weight of dry calcium chloride. After being left in contact for twenty-four hours it is distilled in the water-bath. The methylic alcohol remains in combination, whilst the other volatile products pass over. When all the volatile matter has thus been driven off there is added to the fixed residue a quantity of water equal to the weight of the chloride, and it is re-distilled, we obtain then the methylic alcohol more or less diluted with water, but its quantity can be exactly determined.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 11.

Production Cost of Farmyard Manure.—A. Dettweiler.—From seemingly exact observations made on four farms, the yearly produce of a cow is 260 cwts. dung yearly, and if the value of the mineral plant-food is taken

at 34·84s., the 117 lbs. of nitrogen in the dung cost at Wintersheim 4·87s., at Laubenheim 13·2s., and Nierstein 0·0s., and at Guntersblum 69·9s. These figures have to be increased by rent, interest on capital sunk, &c.

Manurial Experiments on the Experimental Farm, Peterhof, near Riga.—Prof. W. Knieriem.—Superphosphate and precipitated phosphate of lime were found nearly equal in their action, as it has been also observed elsewhere in soils very rich in humus.

Cause of Differences in the Analysis of Superphosphates.—Prof. M. Märcker.—Boxes of zinc, sheet-iron, tinned iron, &c., are not admissible for sending samples of superphosphate, or for preserving them for reference. In a sample of superphosphate which contained originally 20·09 per cent soluble phosphoric acid there became insoluble in five days 0·38 per cent, and in twenty-five days 1·43 per cent of phosphoric acid.

Researches on the Influence of the Bulk of the Soil upon the Development of the Roots of certain Cultivated Plants.—Prof. Hellriegel.—A physiological paper.

Comparative Value of Factitious and Genuine Butter.—Prof. Mayer and P. Udall.—The author finds in a series of comparative experiments that a larger percentage of genuine butter is assimilated than of "oleomargarine." The difference, though unimportant for healthy adults, may prove of moment to sick persons, convalescents, and young children. The taste of the artificial butter was found under certain circumstances tallowy. Udall points our certain possible sources of error in Mayer's experiments, which, he thinks, may have affected the result unfavourably as regards the digestibility of factitious butter. He doubts, however, the harmlessness of the latter article, as bad fat may have been employed in its preparation.

Saccharine and its Derivatives.—Dr. H. Kiliani, Prof. Liebermann, and Prof. Scheibler.—An account of saccharone and saccharonic acid.

Determination of Sugar in Beets.—Dr. K. Stammer and Dr. E. Sostmann.—The authors find that the four different methods of determination by the polarising process do not give accordant results.

MEETINGS FOR THE WEEK

Monday, Feb. 4th.—Medical, 8.30.
— London Institution, 5.
— Royal Institution, General Monthly Meeting, 5.
— Society of Arts, 8. "Recent Improvements in Photo-Mechanical Printing Methods," by T. Bolas, F.C.S.
— Society of Chemical Industry, 8. "The Disposal of Sewage Sludge," by C. C. Hutchinson; "The Porter-Clark Process," by J. H. Porter; "Keiselguhr and its Technical Applications," by Mr. Haacke.

Tuesday, 5th.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.

Wednesday, 6th.—Society of Arts, 8. "Suggestions on the Re-housing of the Poor, and Reconstruction of Central London," by William Westgarth.
— Geological, 8.
— Pharmaceutical, 8.

Thursday, 7th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
— London Institution, 7.
— Chemical, 8. "On the Influence of the Temperature of Distillation on the Composition of Coal-Gas," by L. T. Wright; "Researches on Secondary and Tertiary Azo-compounds, No. II.," by R. Meldola.

Friday, 8th.—Royal Institution, 8. "The Darwinian Theory of Instinct," by G. J. Romanes, at 9.
— Astronomical, 8. (Anniversary.)
— Quekett Microscopical Club, 8.

Saturday, 9th.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.
— Physical, 3. Annual General Meeting.

THE CHEMICAL NEWS.

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ON THE

ELECTROLYSIS OF DILUTE SULPHURIC ACID AND OTHER HYDRATED SALTS.*

By J. H. GLADSTONE, Ph.D., F.R.S., and ALFRED TRIBE, Lecturer on Chemistry in Dulwich College.

ON the 1st of March last a communication was presented to the Royal Society by Professor Frankland, in which, among other things, the reactions we had described as taking place in the charging and discharging of secondary batteries were confirmed. The author expressed these reactions, however, by formulæ founded on the electrolysis, not of H_2SO_4, but of hexabasic sulphuric acid, H_6SO_6, in accordance with the views of Bourgoin.

The point of difference is a small one, but it led us to look into the papers of Bourgoin, and to examine the evidence upon which his views were based. The French chemist (*Ann. de Chimie*, 1868) treats of the electrolysis of sulphuric acid merely as an illustration of his method for determining the composition of hydrated salts in solution generally. This method consists in electrolysing a given solution in a divided cell, analysing the liquid in each compartment at the close of the experiment, and, in the case of dilute sulphuric acid, collecting the hydrogen set free. In the case of a solution of sulphuric acid, of course, the positive compartment may be expected to increase in strength as a consequence of the electrolytic action, and the negative compartment to decrease in strength in the same degree. Bourgoin calls the increase of the acid in the positive compartment a, and concludes that $2a$ represents the amount of sulphuric acid electrolysed. This conclusion rests on the well-known theoretical views of Grotthus, and, did his theory express all that goes on in the electrolytic process, the method would readily discriminate between the actions represented by the following formulæ —

	Before Electrolysis.		After Electrolysis. Positive pole.	Negative pole.
(1.)	SO_3H_2O	=	SO_3+O	H_2
(2.)	SO_33H_2O	=	SO_3+O_3	H_6
(3.)	SO_3nH_2O	=	SO_3+O_n	H_{2n}

But it was pointed out by Reuss, as far back as 1807, that when electrolytic action occurs across a permeable diaphragm, a portion of the liquid may travel from the positive to the negative compartment of the compound cell by what is now call electrical endosmose. Daniell and Miller (*Phil. Trans.*, 1844) pointed out that in electrolytic action there was also an unequal transference of the ions. It is evident that each of these actions must introduce additional terms into the formula with which Bourgoin worked. Moreover, Daniell (*Phil. Trans.*, 1839) investigated the electrolysis of sulphuric acid of very different strengths by a similar method, and on a review of the evidence (*Phil. Trans.*, 1840) concluded that for each equivalent of hydrogen liberated, the acid which passed across the diaphragm was not more than one-fourth nor less than one-fifth of an equivalent. Most of his experiments incline to the former. Did $2a$, therefore, represent the amount of sulphuric acid electrolysed, it would appear from his results that *tetra-*, and not *hexa-*, basic sulphuric acid was decomposed by the current. Again Hittorf, in 1853 (*vide* Wiedemann's "Electricity," vol. ii., p. 589), observed that for one equivalent of hydrogen liberated, the amount of sulphuric acid which was found in the positive compartment varied, but not regularly, with the strength of the acid. These discrepancies, both of observation and deduction, led us to make some experiments on the subject ourselves.

The apparatus we employed consisted of a U-shaped tube of about 70 cub. centims. capacity, having a stop-cock in the centre of the horizontal part. The vertical parts of the apparatus were divided into millimetres, and the hole in the stop-cock packed with asbestos. We found that the closeness of the packing could be so nicely adjusted as to allow neither mechanical admixture of the fluids, on the one hand, nor electrical endosmose on the other. In our experiments we varied the current density, and, unlike Bourgoin (*Ann. de Pharm.*, vol. xv.), found that the increase of sulphuric acid in the positive compartment per equivalent of hydrogen set free decreased along with the decrease in the current density. The strength of acid was 4·2 per cent. The results are set out in the annexed table:—

Current in milli-ampéres.	Time in hours.	Increase of sulphuric acid in positive compartment for one part of hydrogen set free.
32·8	20	9·17
33·4	6	9·5
72·3	2·5	10·3
72·7	2	9·4
106	2	11·0
117	2·5	10·5
215	1·5	12·05
220	1	12·04
229	2	12·31

It is necessary also to bear in mind the remarkable phenomenon, called by the Germans "Wanderung der Ionen." Daniell long ago described an experiment in which he placed dilute sulphuric acid in the positive compartment and a solution of sulphate of copper in the negative. He found that when 15·5 grs. of copper had been deposited on the negative electrode there were 23 grs. of sulphuric acid in the same compartment. Now, as 15·5 grs. of copper are equivalent to 24 grs. of sulphuric acid, and as Bourgoin's formula allows for the formation of only half an equivalent of sulphuric acid, that is 12 grs., it is evident that there was a considerable accumulation of that substance unaccounted for. In two similar experiments made with our apparatus, we obtained for 0·147 and 0·125 grm. of deposited copper respectively 0·209 and 0·180 grm. of free sulphuric acid. The half equivalents would be 0·114 and 0·097 grm. respectively. The excess of acid in all these cases is due to the "unequal transference of the ions." If both compartments had been filled with sulphuric acid, some similar transference would doubtless have taken place, in addition to what is expressed in Grotthus's chain of decomposition.

We conclude, therefore, from our own results, as well as from those of previous experimenters, that the method employed is incapable of determining whether it is H_2SO_4 or some hydrate which yields to the current.

Copper Sulphate.

A careful examination of the chemical changes which accompany the electrolysis of a solution of copper sulphate appeared, however, capable of throwing additional light on the value of this electrolytic method for ascertaining the composition of hydrates in aqueous solution. It is well known that water forms with $CuSO_4$ a definite hydrate, $CuSO_45H_2O$. The anhydrous salt is white, the hydrate blue. It is reasonable to suppose that the blue solution of this salt contains molecules of this or of some higher hydrate. Now, if in the electrolytic process the water of hydration suffers decomposition along with the $CuSO_4$, the primary chemical changes might be expected to be—

$$\text{(A.)}\quad CuSO_45H_2O = \overbrace{SO_3+O_6}^{\text{Positive pole.}} \quad \overbrace{Cu+5H_2.}^{\text{Negative pole.}}$$

* A Paper read before the Royal Society, January 17th, 1884.

But, if the water of hydration takes no more part in the electrolysis than the water of solution does, then the chemical changes would manifestly be—

$$\text{(B.)}\quad CuSO_4 = \overbrace{SO_3+O}^{\text{Positive pole.}} \quad \overbrace{Cu.}^{\text{Negative pole.}}$$

Of course the collateral action—

$$H_2O = \overbrace{O}^{\text{Positive pole.}} \quad \overbrace{H_2}^{\text{Negative pole.}}$$

might also take place, but this would occur only with currents of considerable density. The method is obviously capable of discriminating between these two actions, even supposing that a considerable quantity of the electrolyte travelled unchanged from one compartment of the apparatus to the other. For, in the first case, either free hydrogen would be liberated at the negative pole, or free acid formed in the negative compartment, equal to five-sixths of the total copper deposited; the free acid, and the five-sixths of the total copper, to which it is equivalent, being produced by the chemical action—

$5H_2+5CuSO_4=Cu_5+5H_2SO_4$; equation A becoming—

$$CuSO_4.5H_2O+5CuSO_4 = \overbrace{SO_3+O_6}^{\text{Positive pole.}} \quad \overbrace{Cu_6+5H_2SO_4.}^{\text{Negative pole.}}$$

On the other hand, if the action was in accordance with B there would be only a deposition of copper on the negative electrode, and no formation of free acid in the negative compartment. In the annexed table the results and particulars of several experiments are set out. In each experiment 25 cub. centims. of a 10 per cent solution of sulphate of copper were placed in the negative and positive compartments respectively of the apparatus. The positive electrode consisted of a platinum wire, and the negative of a weighed strip of metallic copper:—

Experiment.	Time in hours.	Free sulphuric acid. Pos. Compart.	Neg. Compart.
I.	1½	0·0766	nil.
II.	2	0·0936	nil.
III.	3	0·1868	0·0191
IV.	3	0·1501	0·0204
V.	3	0·2442	0·0237
VI.	3	0·2546	0·0372

In none of these experiments was there any trace of hydrogen visibly escaping from the negative electrode, while, as will be seen from the table, there was no free acid formed in the negative compartment till two hours or more had elapsed. By that time some admixture in the horizontal part of the apparatus might reasonably be expected, and even in the greatest instance it is small as compared with the amount of salt decomposed.

Similar experiments were made with the sulphate of zinc, with similar results, no hydrogen being involved, and little or no sulphuric acid appearing in the negative compartment.

We conclude, therefore, that it is not possible to determine the composition, or even to show the presence of a hydrated salt in aqueous solution by means of this electrolytic method.

THE ANALYSIS OF SILICATES.

By W. KNOP.

THE author fuses 2 grms. of the finely pulverised sample with 10 grms. of sodium carbonate. When the crucible is perfectly cold, the melt, which detaches itself from the crucible all round, is placed in a capsule of at least 20 centimetres in capacity, and covered with 200 c.c. of water. The residues of the melt adhering to the capsule are dissolved in hot water and the solution is poured into the capsule, which is then allowed to stand for forty-eight hours at the common temperature. The melt swells up spontaneously and its solution is promoted by stirring every six or eight hours, so as to make the hard nucleus of the melt accessible afresh to the action of the water. After the melt is thus completely softened a quantity of sal-ammoniac, sufficient for its complete decomposition, is added, and the whole is evaporated to dryness at a temperature of 80° to 90°.

To find the needful quantity, 10 grms. sodium carbonate are dissolved in water coloured with litmus, and strong hydrochloric acid is added until the solution is reddened, for which 30 c.c. of acid are generally needed. Double the quantity, *i.e.* 60 c.c., of hydrochloric acid are then measured out, completely neutralised with ammonia, a slight excess of which is not injurious, and the solution thus obtained is added to the contents of the capsule.

The dried up matter is then covered with water, heated to a gentle boil for a quarter of an hour, and thus manganous chloride and phosphate of lime are brought into solution. They are filtered off, and there remains upon the filter a mixture of free silicic acid, insoluble in water and in acids, and of the undecomposed silicates of the sesquioxides.

From the filtrate the manganous oxide and phosphate are first separated. If the latter is present the solution passes clear through the filter only whilst it is concentrated. Subsequently, when it is diluted by the washing water, the manganous phosphate separates out in the filtrate as a milky turbidity, and thus the presence of traces of phosphoric acid in the mineral is made known. The residue on the filter is washed completely, without regarding the turbidity, until the water passing through shows no reaction of chlorine, and the filtrate is evaporated down to about 150 c.c. in a roomy capsule.

The liquid is then made slightly alkaline with ammonia and the manganese is precipitated by means of chlorine water. After standing from four to six hours on a water-bath at 50° to 60°, the manganese falls as a flocculent precipitate of hydrated manganese peroxide and manganic phosphate. Care must be taken to keep the liquid alkaline by the occasional addition of ammonia. If this is omitted a part of the precipitate re-dissolves. The precipitate is collected upon a filter large enough to receive subsequently the entire silicic acid, and lime and magnesia are then determined in the filtrate in the usual manner.

The silica and the sesquioxides remain upon the first filter. It is spread upon a glass plate, the contents are pushed with a glass rod into a capsule, the filter is washed into the capsule, pressed, dried, and burnt, and its ashes are also rinsed into a capsule. A sufficiency of hydrochloric acid is added, and the liquid is evaporated to dryness. The residue is treated with hydrochloric acid, and the silicic acid is filtered in the same filter upon which the manganese deposits were collected. The latter are re-dissolved by the acid liquid, and are washed away. On the filter there remains the silica in a state of purity, whilst alumina, iron, and manganese are separated in the filtrate.—*Zeitschrift Analyt. Chemie.*

THE UTILISATION OF THE RESIDUES OF PYRITES.

By M. J. CREUTZ.

IN 1874, M. P. W. Hofmann pointed out the occurrence of zinc in the burnt pyrites of chemical works, and proposed to make it available by means of a process which he described in the *Zeitschrift des Vereins Deutscher Ingenieure.* This process, which has been in operation for some years at the Wocklum Works, yields zinc chloride, which is sold at the average price of 10 francs per 100 kilos.

The treatment consists in lixiviating the burnt ore, and thus extracting the iron and copper sulphates; the lixivium,

concentrated to crystallisation, is mixed with a quantity of sodium chloride equivalent to the quantity of zinc sulphate dissolved, and deposits at first Glauber's salts, the value of which alone covers the whole expense of the treatment.

When the concentration reaches 50° B., various mixed ferrous and sodium sulphates separate out, and there remains in the mother-liquor merely zinc chloride, which is obtained by evaporating to dryness.

Notwithstanding the advantages which Hofmann's process offers at first sight, it has not been widely adopted. It must be observed, in fact, that the reactions do not take place as simply as it has been just described, and the separation of the salts is not sharply marked.

The sulphate of soda is not deposited entirely, and the liquors evaporated after crystallisation yield a dry mixture containing about 85 per cent zinc chloride and 15 per cent of sodium salts. The presence of these latter bodies, according to M. J. Creutz, is inconvenient in the application of zinc chloride to the preservation of wood.

According to an American patent (No. 236,051), claiming the reactions above mentioned, it is important to effect the mixture of sodium chloride with the solution of the sulphates at a low temperature. This indication may be previously found in *Dingler's Polytech. Journal*, vol. 153, p. 157.) In order to cool the liquids most suitably they are brought in contact with the refrigerating apparatus at their upper surface only. The process, thus modified, still does not give a zinc chloride sufficiently pure for the treatment of wood. Moreover, on melting a mixture of white vitriol and of salt, and dissolving the product in water, the first lixivium, at 48° B., always furnishes a dry product containing about 20 per cent of salts of sodium. It is also known that there exist several double salts of zinc and sodium, and it is hence not surprising that it should be found to separate sharply the salts of these two elements by crystallisation.

Hofmann has further studied a process patented in 1877 by Rivière de la Souchère: the double decomposition of iron and zinc sulphates by sodium or calcium chloride, and the precipitation of zinc oxide by lime. The results have been more favourable, and they have led to a method of treatment which is really practicable and advantageous. The burnt pyrites are exposed for some time to the air, in order that the compounds of iron and manganese and the sulphurous acid may be more completely oxidised. They are then systematically exhausted with cold water in a circulatory apparatus, which consists of three or four large tanks with false bottoms, arranged in stages; the liquid flows out at a plug-hole below, and passes through a lead pipe into the next tank below.

From burnt pyrites containing on an average 3 per cent of zinc, there is obtained a liquor marking about 20° B., and almost free from iron, with traces of manganese and cobalt. There is mixed with it a solution of calcium chloride at about 15° B. In a few moments there is produced a thin magma of calcium sulphate. It is well, when effecting this double decomposition, not to use calcium chloride in excess.

The filtrate marks about 10° B., and contains, along with zinc chloride, zinc and calcium sulphates and traces of manganese and cobalt. It is evaporated in pans heated by reverberation, because heat applied from below would occasion an incrustation of calcium sulphate. By adding a little chloride of lime to the boiling liquid the cobalt and manganese are precipitated. The last traces of calcium sulphate are deposited when the solution marks about 48° B.; it then contains merely zinc chloride and a little sulphate, and consequently corresponds in composition with the zinc chloride obtained by dissolving zinc in hydrochloric acid containing a little sulphuric acid.

The inconvenience of this process lies in the dilution of the zinc chloride obtained, which must be concentrated from 10° to 48° or 50° B. This is not the case with Hofmann's method, which, further, yields a saleable accessory product, the Glauber's salt. Still the calcium chloride process seems to have the advantage, as it alone yields a zinc chloride applicable to all purposes.

The author has sought to avoid the difficulty by lixiviating the burnt pyrites with a solution of calcium chloride. But, as might be expected, the extraction of the zinc remains in this case very incomplete; the calcium sulphate formed by double decomposition diminishes the porosity of the substance, and hinders the solution of the zinc sulphate. Calcium chloride, also, dissolves much iron and manganese, and nearly all the copper.

The production of zinc chloride by the process above described is most advantageous if we wish to prepare zinc hydroxide for desulphuring alkaline lyes. There is then no need to concentrate the liquors: they are simply treated with milk of lime, which throws down the hydroxide, whilst the lime dissolves as calcium chloride. After well stirring, the oxide is let settle, the solution run off, the deposit washed once by decantation, and the paste is spread on a sand-filter. The washing-water is absorbed by the sand, and the zinc oxide, in the state of a paste, is at once used for desulphurising caustic lyes.

In 1880, K. W. Jurisch proposed, instead of oxidising the red liquors by means of sodium nitrate, to desulphurise by means of zinc oxide. The zinc method yielded, according to his calculations, a saving of 14 to 15 francs per ton of caustic soda. But his zinc hydroxide was prepared by dissolving zinc in hydrochloric acid and precipitating with lime. Hence, if zinc hydroxide is obtained from burnt pyrites, taking labour and the cost of lime into account, there would be, as compared with the estimate of Jurisch, a further saving of 17 francs 65 centimes per 1000 kilos., or a total gain of 33 francs by the desulphurising process with zinc oxide.

This process might even be used for desulphurising the lixivium of black-ash. The zinc thus employed is lost, but its cost price in this case is so trifling that in many works it would be advantageous to extract the burnt pyrites.

The burnt ores being thus to a great extent freed from sulphur and zinc, which are troublesome impurities in its metallurgical treatment, would be sold doubtless for a better price than pyrites not treated.—*Revue Scientifique Quesneville.*

ON CARBONYL-DIPHENYL-OXIDE AND OXY-DIPHENYLEN-KETONE, TWO KETONES FORMED FROM SALICYLIC ACID, AND THEIR DERIVATIVES.

By R. RICHTER.

By the action of phosphorus oxychloride:—

I. Upon basic sodium or potassium salicylate or upon potassium salicylic ether, there is formed a ketone which may be regarded as carbonyl-diphenyl-oxide. This compound is converted by hydriodic acid and zinc powder into methylen-diphenyl-oxide, and this again with phosphorus chloride yields a bibasic ether-phosphoric acid.

Or, by fusion with potassic hydrate into carbonyl-dioxy-diphenyl, or into salicylic acid and phenol.

Or, by sodium amalgam into a compound—

$$\left\{\begin{matrix}(C_{12}H_8O)CO\\(C_{12}H_8O)CH_2\end{matrix}\right\}$$

Or, by the action of bromine, nitric and sulphuric acid into substitution derivatives.

II. By the action of phosphorus oxychloride upon neutral sodium salicylate or upon salicylic ether, there is formed an isomer of the above which may be regarded as oxy-diphenylen-ketone. It is decomposed:—

1. By ignited lime into diphenyl-ketone and diphenylen-oxide.
2. By zinc powder into diphenyl, and a body very readily soluble in alkali.

3. Its substitution-derivatives with bromine, nitric and sulphuric acid are more readily prepared than those of the isomeric ketone, and the nitration is attended by the elimination of an atom of carbon.

III. By the action of phosphorus oxychloride :—

a. Upon neutral potassium salicylate there is observed a different behaviour from that of the corresponding sodium salt ; the product contains phosphoric acid.

b. Upon neutral sodium meta-oxy-benzoate there is obtained an acid free from chlorine and phosphoric acid.

c. Upon neutral sodium para-oxy-benzoate there is obtained a neutral product containing chlorine.

IV. Phosphoric phenyl-ether yields carbonyl-diphenyl-oxide with the salts of all the three oxy-benzoic acids.

Other accompanying reactions occasion, *e.g.*, with sodium salicylate, the formation of the following bodies : ortho-phenyl-benzoic acid, diphenyl-oxide, and phenylen-oxide.—*Journal für Praktische Chemie.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B., Chief Chemist to the U.S. Geological Survey, Washington.

IRON.

The atomic weight of iron has been determined almost exclusively from the composition of ferric oxide. Beyond this there are only a few comparatively unimportant experiments by Dumas relative to ferrous and ferric chlorides.

Most of the earlier data relative to the percentage of metal and oxygen in ferric oxide we may reject at once, as set aside by later investigations. Among this no longer valuable material there is a series of experiments by Berzelius, another by Döbereiner, and a third by Captaine. The work done by Stromeyer and by Wackenroder was probably good, but I am unable to find its details. The former found 30·15 per cent of oxygen in the oxide under consideration, while Wackenroder obtained figures ranging from a minimum of 30·01 to a maximum of 30·38 per cent.†

In 1844 Berzelius‡ published two determinations of the ratio in question. He oxidised iron by means of nitric acid, and weighed the oxide thus formed. He thus found that when O = 100 Fe = 350·27 and 350·369.

Hence the following percentages of Fe in Fe_2O_3.

70·018
70·022

Mean 70·020 ± 0·0013

About the same time Svanberg and Norlin|| published two elaborate series of experiments ; one relating to the synthesis of ferric oxide, the other to its reduction. In the first set pure pianoforte wire was oxidised by nitric acid, and the amount of oxide thus formed was determined. The results were as follows :—

1·5257 grms. Fe gave	2·1803 Fe_2O_3.	69·977 per cent Fe.
2·4051 ,,	3·4390 ,,	69·936 ,,
2·3212 ,,	3·3194 ,,	69·928 ,,
2·32175 ,,	3·3183 ,,	69·968 ,,
2·2772 ,,	3·2550 ,,	69·960 ,,
2·4782 ,,	3·5418 ,,	69·970 ,,
2·3582 ,,	3·3720 ,,	69·935 ,,

Mean 69·9534 ± 0·0050

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† For additional details concerning these earlier papers I must refer to Oudeman's monograph, pp. 140, 141.

‡ *Ann. Chem. Pharm.* 50, 432. *Berz. Jahresb.*, 25, 43.

|| *Berzelius's Jahresbericht*, 25, 42.

In the second series ferric oxide was reduced by ignition in a current of hydrogen, yielding the subjoined percentages of metal :—

2·98353 grms. Fe_2O_3 gave	2·08915 Fe.	70·025 per cent.
2·41515 ,,	1·6910 ,,	70·015 ,,
2·99175 ,,	2·09455 ,,	70·014 ,,
3·5783 ,,	2·505925 ,,	70·030 ,,
4·1922 ,,	2·9375 ,,	70·072 ,,
3·1015 ,,	2·17275 ,,	70·056 ,,
2·6886 ,,	1·88305 ,,	70·036 ,,

Mean 70·0354 ± 0·0055

It is evident that one or both of these series must be vitiated by constant errors, and that these probably arise from impurities in the materials employed. Impurities in the wire taken for the oxidation series could hardly have been altogether avoided, and in the reduction series it is possible that weighable traces of hydrogen may have been retained by the iron. At all events it is probable that the errors of both series are in contrary directions, and, therefore, in some measure compensatory.

In 1844 there was also published an important paper by Erdmann and Marchand.* These chemists prepared ferric oxide by the ignition of pure ferrous oxalate, and submitted it to reduction in a stream of hydrogen. Two sets of results were obtained with two different samples of ferrous oxalate, prepared by two different methods. For present purposes, however, it is not necessary to discuss these sets separately. The percentages of iron in Fe_2O_3 come out as follows :—

70·013
69·962
69·979 } A.
70·030
69·977

70·044
70·015 } B.
70·055

Mean 70·0094 ± 0·0080

In 1850 Maumené's† results appeared. He dissolved pure iron wire in aqua regia, precipitated with ammonia, filtered off the precipitate, washed thoroughly, ignited, and weighed, after the usual methods of quantitative analysis. The percentages of Fe in Fe_2O_3 are given in the third column :—

1·482 grm. Fe gave	2·117 grms. Fe_2O_3.	70·005 per cent.
1·452 ,,	2·074 ,,	70·010 ,,
1·3585 ,,	1·941 ,,	69·990 ,,
1·420 ,,	2·0285 ,,	70·002 ,,
1·492 ,,	2·1315 ,,	69·998 ,,
1·554 ,,	2·220 ,,	70·000 ,,

Mean 70·0008 ± 0·0019

Two more results, obtained by Rivot,‡ through the reduction of ferric oxide in hydrogen, remain to be noticed. The percentages are :—

69·31
69·35

Mean 69·33 ± 0·013

We have thus before us six series of results, which we may now combine.

Berzelius..	70·020	± 0·0013
Erdmann and Marchand	70·0094	0·0080
Svanbeg and Nordlin, Oxyd. ..	69·9534	0·0050
,, Reduc. ..	70·0354	0·0055
Maumené	70·0008	0·0019
Rivot	69·33	0·013
General mean	70·0075	0·0010

* *Journ. f. Prakt. Chem.*, 33, 1.

† *Compt. Rend.*, Oct. 17, 1850.

‡ *Ann. Chem. Pharm.*, 78, 214, 1851.

From this we get Fe=55·891 ± 0·012; or, if O=16, this becomes 56·0195.

Dumas's† results, obtained from the chlorides of iron are of so little weight that they might safely be omitted from our present discussion. For the sake of completeness, however, we will include them.

Pure ferrous chloride, ignited in a stream of hydrochloric acid gas, was dissolved in water and titrated with a silver solution in the usual way. 100 parts of silver are equivalent to the amounts of $FeCl_2$ given in the third column:—

3·677 grms. $FeCl_2$	=6·238 grms. Ag.	58·945
3·924 ,,	6·675 ,,	58·787
		Mean 58·866 ± 0·053

Ferric chloride, titrated in the same way, gave these results:—

1·179 grm. Fe_2Cl_6	=2·3475 grms. Ag.	50·224
1·242 ,,	2·471 ,,	50·263
		Mean 50·2435 ± 0·0132

These give us two additional values for Fe, as follows:—

From $FeCl_2$	Fe=56·028 ± 0·119
,, Fe_2Cl_6	,, 56·189 0·062

Combining these with the value deduced from the composition of Fe_2O_3, Fe=55·891 ± 0·012, we get this general mean, Fe=55·913 ± 0·012. If O=16, this becomes Fe=56·042.

† *Ann. Chem. Pharm.*, 113, 26. 1860.

NOTES ON THE AMMONIA PROCESS FOR WATER ANALYSIS (ILLUSTRATED BY THE PUMP-WELL WATERS OF BROOKLYN AND NEW YORK CITIES).

By NELSON H. DARTON.

It is with hesitation that I add to the now almost too voluminous literature of water analysis. The investigations of which I wish to give results have revealed, however, considerable matter of interest, especially in regard to the volatile nitrogenous matters which for some time have been known to be a constituent of polluted potable waters. Remsen, in his report on Boston water, in 1881, called attention to them more definitely, and Marsh quite recently has shown their influence on the results obtained in the analysis of even slightly contaminated waters.

The importance of recognition of these volatile constituents which are generally lost sight of in the ordinary method of analysis, as they pass over with the free ammonia but do not affect the Nessler reagent, is, however, as yet undetermined, and by investigations of its physiological action in the concentrated state upon rabbits I have been enabled to draw conclusions which I trust will not be without value in judging the character of a potable water, as the sequel will show.

It was also very desirable to investigate its association with the other ingredients generally present in contaminated waters; to what extent these relations change by allowing the waters to stand, and of the microscopic growths present in the waters examined; consequently the research was extended to include all these data as completely as the facilities in my laboratory would allow, and are given in the tables.

The waters selected for the investigations were known to be polluted with sewage and decomposing vegetable matter, and highly charged with these volatile nitrogenous matters of which I wished more particularly to investigate the characteristics. These were the well-waters of Brooklyn, more familiarly known as "pump waters." There are about three hundred of these wells and their pumps, most of them less than a hundred feet in depth, that yield a plentiful supply of cool, clear water even in the dry seasons. The sources of supply of these wells, or in other terms their water-sheds, are almost exclusively from water in filtering through the cobble-paved streets and backyards of houses, then through gravel and sand, finally collecting in impervious depressions, generally of clay, underlying the city. The area drained to each pump is quite extensive, as Brooklyn is built upon the slopes of numerous hills. So far as I can find, there was no system followed in locating the pumps; they are more abundant in the lower and older wards of the city, now populated by the poorer classes, and having with few exceptions the highest death rates of any portion.

The sources of pollution of these waters are numerous. The principal one is by infiltration—first through the filthy streets, covered with animal excreta and decomposing vegetable matter, then through the soil and subsoil, saturated with accumulated decayed and slowly putrefying matter, whose only source of elimination is by these waters—much of this finds its way to the sea, but no small proportion of it is raised in the pumps. Another source of pollution which I am led to believe is a very considerable one, is from the loosely built sewers and carelessly-joined drainage pipes from the houses. Then, again, from the loosely-floored stables, manure pits, corner cesspools, and closets in many of the backyards a great amount of sewage drains into the ground and adds to the pollution. There is naturally little or no opportunity for purification of these waters by aëration.

Three of the few remaining pumps in New York city were included in the investigation for comparison. These wells are similarly polluted to those of Brooklyn. Thirteen wells are indiscriminately selected, numbered in the table from Nos. 75 to 88, and including the three New York city wells.

The analyses were made at three intervals, first on the same day that they were drawn; second, after standing forty-eight hours, and third, after six days. During these intervals they were kept in bottles but half-filled and loosely stoppered.

The results were obtained as follows:—

Residue.—50 c.c. evaporated, dried for three hours at 100°, and weighed.

Loss on Ignition.—The above residue was ignited for twenty minutes, cooled, and weighed. Carbonic acid water was not added.

Chlorine.—Titration on 50 c.c.

Nitrites.—According to Preusse and Tiemann's description of the application of Griess's test (meta-diamidobenzol).

In these and other colorimetric examinations the colours obtained were compared with those produced in solutions of known strength of the constituent sought.

Nitrates.—By the zinc-copper-couple as described by Thorpe.

Oxygen Required.—By the moist combustion method of Wanklyn, half the quantities prescribed by him being taken.

Ammonia, free and albumenoid, by Wanklyn's method.—To obtain permanganate solution free from ammonia the following process was followed:—Freshly fused potassa was allowed to cool out of contact with the air in an exhausted bell glass; this and the proper amount of permanganate were dissolved in sufficient absolutely ammonia free water, readily obtained by re-distilling Ridgewood water with the proper precautions. The solution thus made was boiled in a distilling flask with a mark on its neck whereunto it held half a litre of water at 100° C.; it was connected with a condenser, and when 10 c.c. of distillate was found to be free from ammonia, the flask was filled with pure boiling-water and poured into thoroughly cleansed, small hot bottles of about 100 c.c. capacity, for which it was used. Frequent tests of this method re-

vealed not even a trace of ammonia, even when distilling from a half a litre and collecting the first 10 c.c. of distillate.

For measuring this solution a pipette of the form that I proposed before the Society some time ago* but with a three foot length of rubber tubing and two strong pinch-cocks. Upon it were two marks, one at 10 c.c. capacity, the other on the stem at 1 c.c.

In every instance 100 c.c. of the water was taken and the distillation conducted in 250 c.c. in distilling flasks of German glass.

Precautions were taken against the disturbing influence of ammonia in the air of the laboratory by placing dishes of dilute hydrochloric acid in the niche which was devoted exclusively to the water analyses. This did not, however, appear to be necessary.

In the estimation of the volatile nitrogenous matters 100 c.c. of the water were distilled, and every 10 c.c. of distillate diluted to 20 c.c. and then divided into two portions, one of which was Nesslerised directly and confirmed the free ammonia found in the first distillation, and the remaining portion placed in a 35 c.c. distilling flask joined to a miniature but effective condenser, some water and 1 c.c. of the permanganate mixture added and re-distilled—the 1st 10 c.c. of distillate always contained all the NH_3 and was Nesslerised, the difference between this and the first result being equivalent to the ammonia from the volatile nitrogenous matters. In order to determine some of its characteristics, if possible, all the waters examined were concentrated from 5 litres to 50 c.c. This we readily accomplished by distilling at first in half litres and collecting each first 100 c.c. distillate; these were mixed and the litre obtained distilled in two portions, each first 100 c.c. of distillate being likewise collected; to this a calculated amount of phosphoric acid was added to hold back the free ammonia, 50 c.c. was then distilled off and after re-distillation was found to be quite free from ammonia. After filtration through asbestos felting 1 c.c. distilled with sufficient permanganate mixture and the ammonia Nesslerised, showed that about two-thirds of the NH_3 of the volatile nitrogenous matter had been secured and all other bodies, both chemical and organised, had been left behind.

A number of fine young rabbits were selected and sufficient amounts of these concentrations were injected under their skin with the effects detailed after each table. This it was expected would confirm a suspicion that I had long entertained that these matters were deleterious to the animal economy, and is, I think, fully justified by the results obtained.

Microscopic examinations were made of the sediments from the waters which were generally very slight; and the various forms of life found, so far as I could identify them, are detailed after the tables. In order to separate and examine the Bacilli, Micrococci, and similar organisms, two methods of separation, or rather concentration, were tried, the first by adding osmic acid and allowing that which had been killed by its action to deposit; and the other by developing in a film of gelatin; both of these methods were found to yield quite satisfactory results, but preference was given to the latter on account of its larger yield. Before covering with the film a small amount of Cohn's developing liquor was added to the water. The dissolved gases were determined by the usual method of distillation and absorption by potash and pyrogallate of potassa. It may be well here to recall the significance of the relations of the proportions of the gases dissolved in water and their change upon standing. Water, under the most favourable conditions of purity and at 15° C., will dissolve 6·3 c.c. of oxygen and 11·7 c.c. of nitrogen, and the relation is only disturbed to any great extent by putrefaction of matter held in solution and also by the action of ferments.

At about the time that the research was commenced Dr. A. R. Leeds in a preliminary, and as yet unpublished, communication to the N. Y. Academy of Sciences, called attention to a new actinic method for determining putrescible organic matter in potable waters, which, in a number of trials he had found to yield extremely satisfactory results. Consequently it was thought desirable to include an investigation of the value of this new method.

The details of the process were orally communicated to me, and were quite closely followed. One hundred c.c. of the water is mixed with the same amount of decinormal silver solution, preferably the nitrate; the mixture in a closed bottle is exposed to light as long as it is acted upon, and the decomposition has been completed, the putrescible organic matter having been oxidised at the expense of the silver, which precipitates as metal. All is then poured through a Gooch filter, and this and the bottle washed with ammonia to dissolve haloid salts. The silver adhering to the inside of the bottle and that on the filter is then dissolved in nitric acid and determined as may be convenient; its weight in milligrammes multiplied by 10 equal parts per million, and by the ratio of 108 : 16, equal oxygen required.

This process has so far yielded the most satisfactory results, and promises to be a convenient, applicable, and accurate method for the analysis of potable waters, if not alone, at least with the ammonia process, and when appreciable amounts of sulphides are absent.

The location of the wells and results of the physical and physiological examinations of the waters were as follows:—The effects on rabbits here spoken of are the effects produced by the subcutananeous injection of a small portion of the concentrated nitrogenous matter obtained as described.

No. 75. Corner of Johnson and Lawrence-streets.

Appearance in 2 ft. tube, bright and clear. Sediment slight. Microscopical examination of sediment:—Sand, fibrous, vegetable matter, a cyprus, diatoms, and a few yellow algæ.

The concentrated volatile nitrogenous matter injected under the skin of a rabbit caused violent diarrhœa, with vomiting and death in about an hour.

No. 76. Near corner of Myrtle-avenue and Lawrence-street.

Bright and clear. Sediment considerable, containing much sand, also, *confervæ*, *desmids*, *oscillatoræ*, *palmaceæ*, and *volvox*, two varieties of *amœba*, a *chilodon*, an *augi-nuillata*, *fluviataalis*, and numerous diatoms.

The effect of the concentrated nitrogenous matter on a rabbit was essentially the same as with No. 75, but more intense.

No. 77. Corner of Bridge and Tillary-streets.

Bright and clear. Sediment small, containing sand, fibrous vegetable matter, some diatoms, and a few dead *chætonotii*. Injection of the nitrogenous matter under the skin of a rabbit produced a slight transitory diarrhœa.

No. 78. Corner of Sumner-avenue and Bainbridge-street.

Strong odour of brewery swill, develops that of H_2S on standing. Sediment abundant, dark coloured, containing numerous algæ and animalculæ. The effect on a rabbit was to produce diarrhœa, cramps, vomiting, and death. A similar effect, though not so rapidly fatal, was produced on a cat.

No. 79. Corner Johnson and Bridge-streets.

Water clear and bright. Sediment small and containing scarcely anything worthy of mention. Effect on a rabbit similar to that of the previous one.

No. 80. Corner Chapel-place and Bridge-street.

140 feet deep. No sediment. Effect on a rabbit slight transitory diarrhœa.

No. 81. Near corner of Irving-place and Fulton-avenue.

Clear and bright. Sediment slight, consisting of sand, *diatoms*, *algæ*, several *cypri*, *chilodons*, and *amœbæ*. Effect on a rabbit, violent diarrhœa followed by slow recovery.

No. 82. Corner Bridge and Nassau-streets.

Water clear. Sediment large, containing sand, algæ,

* *Journ. Am. Chem. Soc.*, iii., 12.

and monads. The bacteria obtained by filming when injected under the skin of a rabbit caused diarrhœa and death. The same effect was produced by the concentrated nitrogenous matter.

No. 83. Corner Fulton-avenue and Carleton.

Water clear. Sediment inconsiderable. In this water the proportion of total ammonia was much less than the sum of the five and albumenoid together. It probably contained some substances oxidised by the permanganate to nitrates. The tests were duplicated with the same results.

No. 84. Corner Duffield and Johnson-streets.

Water clear. Sediment moderate, containing sand, numerous *diatoms*, *chilodons*, &c. Effect on a rabbit, violent diarrhœa, &c. Death in two days.

Some of this concentrated nitrogenous matter was also injected under my own skin. The effects were similar. Diarrhœa was produced in two hours, and continued for two days.

No. 85. Hanover-place near Fulton-street. Water clear. No perceptible sediment. Effect on a rabbit, intermittent diarrhœa lasting for about a week. The effect on my assistant was to produce a tendency to diarrhœa lasting four days.

No. 86. New York City, corner Thames and Church-streets.

Water clear. Slight odour of acetylene, which soon disappeared. Contained no volatile nitrogenous matter. Effects on a rabbit, nil.

No. 87. New York City, corner Dey and Greenwich-streets.

Water clear. Much sediment. Both the sediment and the volatile nitrogenous matter produced violent diarrhœa, and vomiting with rabbits, which in the case of the sediment terminated in death.

No. 88. Corner Church and Cedar-streets.

Similar to the last. Sediment contained vorticella and microstoma. The volatile nitrogenous matter injected under my own skin produced diarrhœa and vomiting from which I took a week to recover.

To determine whether the above results were exclusively due to the volatile nitrogenous matters and whether they existed in the water as such, or were formed during distillation, further experiments were tried from time to time during the research. That these volatile nitrogenous matters pre-existed in the waters was, I thought, very probable. To ascertain this the waters were, after being filtered through asbestos plugs (in all other respects they were as when drawn from the wells), injected in considerable quantity under the skins of rabbits. Symptons were produced very similar to those induced by the concentrated waters, and the distillates ftom the concentrated waters which had been found not to contain or develop the volatile nitrogenous matters. Well No. 86 greatly polluted, otherwise produced not the slightest discernible effect upon the animal's health, and when the free ammonia was allowed to accumulate in another portion and concentrated till it became two parts per million, on injection it produced exactly similar results.

In order to determine the effect of the less volatile portion of a water, some of that which had been filtered through the asbestos plugs of our other experiment, was distilled at a very low pressure at a temperature of about 84° C., as previous experiments had shown that all the readily volatile matters of this water were easily separated from it by heat, applied if for even a short time. That which remained and was injected in the rabbit produced little or no discernible effect. While in this and the first injectings, bacterial matter might have been implicated, the latter experiment would have failed on account of their sterilisation by the heat applied. Yet the volatile matters, in which in every instance I am sure there were no bacteria present, produced more or less violent diarrhœa, with the exception, I might again mention, of that from well No. 77, which, although when concentrated contained 7 parts per million, an amount equal to that in many of the others, produced no diarrhœa in the rabbit into which it had been injected. The only manner by which I can account for this is by assuming that the term "volatile nitrogenous matters" is a very elastic one, and includes both virulent and harmless amine compounds. Of the former, those of phenol, toluol, &c., and of the latter, ethyl, &c. This is a part of the subject, however, that I trust to be enabled to further elucidate, while it suffices in the present communication to show that the volatile nitrogenous matters accompanying the other pollutants in a sewage contaminated water probably are injurious to health, and that in an examination of a water to determine its potability, their presence and amount should not be lost sight of.—*Journal of the American Chemical Society*.

ON DETERMINING THE ROTATION OF LEFT-HANDED SOLUTIONS WITH THE GERMAN (*SCHEIBLER-VENTZKE-SOLEIL*) INSTRUMENT.

By GEO. S. EYSTER, Ph.D.

The following plan for determining negative rotation, in the absence of an instrument graduated for left-handed solutions, occurred to me some time ago. Though seeming quite obvious, I have not seen it in print.

If we use a + quartz plate reading n degrees to the right (either used instead of one of the cover-glasses, or sunk in an outside recess of one of the brass caps, and secured in place by a thin metal ring and three screws) in connection with a − solution of less rotating power the reading will be N or $n\text{-}x = \text{N} = -x = (\text{N-}n)$ where $-x =$ the rotating power of the solution in degrees of the instrument. For instance:—

The reading of the quartz plate is 90°.

The reading of the plate and solution is 66°, then $-x = 66° - 90 = -24°$.

Or in other words, the solution has lowered the reading from 90° to 66°; hence is left-handed and is equal in value to the difference between 90° and 66°.

It is best to use a plate reading from 80° to 100° rather than one of much less thickness, as apart from the facility it affords for using a double normal solution for inversion, the value and equality of that portion of the scale is better under control.

I have not had a good opportunity to test the method since it occurred to me, but its success, as one acquainted with the principle of the quartz compensator will readily see, is merely a matter of detail.—*Journal of the American Chemical Society*.

SECULAR INCREASE OF THE EARTH'S MASS

By ALEXANDER WINCHELL.

The thoughtful and suggestive researches of Ebelmen and T. Sterry Hunt, on the chemical and geological relations of the earth's atmosphere,* have led me to some further deductions, which seem to increase the interest in this field of inquiry. The general tendency of these studies is to show that the chemical transformations in progress upon the earth involve the fixation of a larger volume of atmospheric constituents than could probably have ever existed in the atmosphere at one time, and that they must consequently have arrived from interplanetary space.

1. *The Carbonates*.—It is generally agreed, as first shown by Hunt, that the carbonates of lime and magnesia

* See a memoir by T. Sterry Hunt in *American Journal of Science*, May, 1880, where references are given to numerous other publications.

have arisen chiefly through the interactions between carbon dioxide of the atmosphere, the decomposing silicates of the earth's crust, and the chloride of calcium of the ocean. The carbon dioxide has therefore been contributed by the atmosphere. To what does this contribution amount? We may assume, without material error, that the carbonates here in question are all calcium carbonate, with a specific gravity of 2·72. Then, the mean pressure of the atmosphere being about 14·7 pounds avoirdupois on a square inch, a little calculation shows that an amount of carbon dioxide in the atmosphere sufficient to double its pressure would yield only 8·627 metres of limestone. An amount sufficient to cause a pressure of 80 atmospheres would suffice for the formation of limestones equal to only a fortieth (0·02265) of the hundred thousand feet which, for this purpose, may be assumed as the thickness of the stratified rocks. But a pressure of 80 atmospheres at a temperature of 30° C. produces liquefaction of carbon dioxide. The actual proportion of limestones and dolomites in the earth's crust is about one-eighth, as I have shown by recent studies. This amount would yield, by the liberation of all its carbon dioxide, a pressure of 441·6 atmospheres. If we consider the limestones and dolomites formed since the period of the coal-measures, the proportion required to yield, on the liberation of its carbon dioxide, a pressure of 80 atmospheres, would be only 1-22nd (0·04469) of all the post-carboniferous strata. The actual proportion is about one-eighth, as for the whole stratified crust; and this would yield sufficient carbon dioxide to cause a pressure of 223·8 atmospheres.

It is not credible that such amounts of carbon dioxide have ever existed in the atmosphere at one time. During the larger part of the aeons of carbonate formation, animal life has existed in great abundance upon the earth; and this would have been impossible with 200 to 400 atmospheres of carbon dioxide present. As the proportion of this gas in the existing atmosphere is only 4½ parts in 10,000 by weight, 200 atmospheres of the gas would be 444,000 times the present proportion. It is scarcely more credible that the pressure of 200 to 400 atmospheres would have been compatible with either vegetable or animal organisation, so similar as it was fundamentally to modern organisation. As this large amount of carbon dioxide cannot be supposed derived from the earth's crust, it must have been derived ftom interplanetary space. This would imply an addition to the earth's mass of 0·0003806, which is about $\frac{1}{2600}$ part of the present mass

2. *The Kaolinisation of Felspars.*—Hunt has shown that the kaolinisation of a layer of 51·66 metres of orthoclase, or its equivalent of quartzo-felspathic rocks, would result in 23·7 metres of kaolin, and would use up 10,333 kilogrms. of carbon dioxide per square metre of surface. This is the weight of the atmosphere. Now, the whole amount of felspathic decomposition during the sedimentary ages must much exceed 500 metres in vertical thickness of kaolinic deposits. But 500 metres of kaolin represent 21·1 atmospheres of carbon dioxide; and, assuming the mass of the atmosphere at $\frac{1}{1200000}$ in relation to the earth, the carbon dioxide fixed in the processes of kaolinisation would be 0·0000175826 of the total mass of the earth.

3. *Decay of Hornblende, Pyroxene, and Olivine.*—According to Hunt, the decay of 10⅓ metres of such minerals, or their equivalents in hornblendic and pyroxenic rocks, would yield carbon dioxide equal to 1 atmosphere: hence, if the earth's crystalline rocks have afforded 500 metres of hornblende and pyroxene, they must have fixed 48·387 atmospheres of carbon dioxide. This, in relation to the earth's mass, is 0·0000403209.

4. *Conversion of Ferrous into Ferric Oxide.*—As Ebelmen states, the conversion of 21,357 kilogrms. of ferrous oxide into 23,750 kilogrms. of ferric oxide would consume the whole of the 2376 kilogrms. of oxygen in the atmosphere (more exactly, 1·007 atmospheres) covering a square metre. If, then, we suppose the existence over the earth of 1000 metres of sediments derived from the decay of crystalline rocks containing only one per cent of ferrous oxide, weighing, according to Hunt, 25,000 kilogrms., this is 1·052 times the amount requisite to fix the oxygen in 1·007 atmospheres; that is, 10 metres of ferric oxide represent the fixation of 1·059 atmospheres of oxygen. This, in relation to the earth's mass, is 0·0000008825.

5. *Unoxidised Carbon.*—This occurs not only in coalbeds, but in pyroschists and petroleum. We find that the oxidation of a layer of carbon 0·7123 metre in thickness would use up all the oxygen in the atmosphere. A layer 2252 metres thick, and having a specific gravity of 1·25, if converted into carbon dioxide, would exert a pressure of 1 atmosphere. This would amount to 2,267,000 tons of 2240 pounds each on a square mile. Mr. J. L. Mott calculates that the amount of unoxidised carbon per square mile cannot be less, and is probably many times greater, than 3,000,000 tons. If we adopt this determination, it will imply a depth of 0·982 metre, and the proportion of the earth's mass will be 0·0000036318. This is the amount of carbon dioxide which must be decomposed to yield a layer of carbon over the earth only a trifle over three feet in thickness, while it is probable that the carbonaceous deposits of the earth's crust exceed this. Now, it will hardly be maintained that the uncombined carbon of the earth's crust was derived from any other source than the atmosphere, and mostly through the agency of vegetation. The earth's atmosphere must therefore have contained all this amount of carbon dioxide. With the fixation of the carbon, the freed oxygen, it may be said, might have been employed, as far as it would go, in the formation of ferric oxide, whose demands upon the atmosphere have just been computed; but as it would only satisfy $\frac{1}{309}$ of those demands, it is hardly necessary to consider the question.

6. *Meteoric Contributions.*—If, as commonly assumed, 400,000,000 meteors enter our atmosphere daily, an average weight of 10 grains each would amount to a yearly addition of 93,170 tons. This, in 100,000,000 years, would amount to 0·000000001542 of the earth's mass, and would form a film 0·292, or nearly $\frac{2}{7}$ of an inch thick, having a density of 2·5.*

Gathering together these various contributions to the earth's mass during 100,000,000 years, we have the following:—

1. CO_2 represented by the carbonates ..	0·0003806
2. CO_2 fixed in kaolinisation of felspars	0·0000175826
3. CO_2 fixed in decay of hornblendic and augitic rocks	0·0000403209
4. O fixed in conversion of ferrous oxide	0·0000008825
5. CO_2 represented by uncombined carbon..	0·0000036318
6. Meteoric contributions	0·000000001542
Aggregate	0·000439750722

This is an addition of $\frac{1}{2416}$ to the earth's mass; and, in the present state of knowledge, it does not appear on what grounds assent can be withheld from the result, or some result of similar purport. It must be left with the astronomer to determine what relation this increase may sustain to the moon's acceleration in its orbit and to other phenomena. It may be noted, however, that the remote secular recession and retardation of the moon, which G. H. Darwin has recently brought to view, would have been delayed by the cause here considered, and the time required for the attainment of the moon's present relations would have been prolonged, but to what extent remains to be determined.

The evidences disclosed by these recent researches, of the slow accession of gaseous and solid matters to the earth, possess a profound interest. It would almost seem that the earth's atmosphere is only so much of the intercosmical mixture of gases and vapours as the earth's mass is capable of condensing around it, and that the proportions of these gases are determined separately, each by its

* The value given for this film in a note, p. 14, in my "Worldlife," should be multiplied by 365¼.

own weight and elasticity and by its relative abundance in space; so that, as any one becomes diminished by fixation in the planetary crust, new supplies arrive to keep the ratio constant. As under this view it is apparent that an atmosphere should be accumulated around the moon, even after the saturation of the pores of its rocks, it may be said that the moon's mass and volume are such that her atmosphere would possess only $\frac{1}{30}$, or according to Neison, $\frac{1}{50}$, the density of the earth's atmosphere; and this degree of tenuity might reduce the lunar atmospheric refraction to the small value actually observed —*Science*, Dec. 28, 1883.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, February 4th, 1884.

The Duke of Northumberland, LL.D., D.C.L., President, in the Chair.

The Earl Percy, M.P., The Lord Sudeley, The Rev. Edward Samuel Dewick, M.A., F.G.S., Mrs. Charles Hawksley, Sidney George Holland, LL.B., William S. Playfair, M.D., F.R.C.P., Augustine Robinson, James Thorne, and Robert Younger, B.A., were elected Members of the Royal Institution.

Sixteen candidates for Membership were proposed for election.

Sir Joseph Hooker, K.C.S.I., C.B., F.R.S., &c., was elected a Manager in the room of the late Sir William Siemens, F.R.S.

The presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
January, 1884.

Force of Explosive Bodies according to Thermochemistry.—M. Berthelot.—A notice of a recent work in which the author has summarised a number of memoirs published in the *Comptes Rendus*, &c.

Treatment of Ores by Electrolysis.—M. Kiliani.—The author lays down general principles for electrolytic metallurgy. Ores must be distinguished as good and bad conductors; the former may serve directly as anodes, and are easily oxidised by the electro-negative radicles formed at their contact, and dissolve readily in the electrolyte. The bad conductors have to be placed in contact with a conducting anode, formed of an inoxidisable substance, such as platinum, manganese peroxide, or coke. In laboratory experiments a good conducting ore is electrolysed by suspension from a platinum wire in connection with the source of electricity, and is then immersed in the bath. On an industrial scale the ore, coarsely broken up, is placed in one of the compartments of a trough divided by a diaphragm. On the fragments of the ore which extend up outside of the electrolytic bath is laid a plate of copper connected with the positive wire. Care must be taken that this plate does not plunge into the bath, otherwise the current would not traverse the ore at all. The cathode is preferably formed of the same metal which is to be obtained. The bath should not contain organic acids. In practice the common mineral acids are employed, or their salts, selecting by preference a salt of the metal which is to be isolated. It is convenient to pass the current through the greatest possible number of small decomposition troughs, taking care that the resistance in each is not too great. With a current of one and the same intensity we obtain in n troughs n times as much metal as in a single one. To keep down the resistance of the circuit we employ poles of a large surface, *i.e.*, plenty of ore and baths which are as good conductors as possible. The state in which the metal is deposited at the negative pole depends on the secondary actions undergone by the electrolyte, and especially of the escape of gas. This is a function of the *density* of the current, *i.e.*, the proportion of its intensity to the surface of the cathode. If the density is too great there is an escape of hydrogen, and the metal is deposited in a spongy condition. If the density of the current falls below a certain minimum an oxide is deposited in place of metal. The electrolytic treatment of ores often renders it possible to separate the different metals which may be present. These are deposited in succession, and are sharply separated if the electromotive power is not too great. 1. Zinc.—The zinciferous compounds, calamine, blende, and zinc ash, are all poor conductors. They are first dissolved, and the salts obtained are electrolysed, employing anodes of coke. Blende should be roasted before it is dissolved. The electrolytic bath should be as concentrated as possible to avoid sponginess of the metal and an escape of hydrogen. In a saturated solution the formation of hydrogen decreases as the density of the current augments. 2. Lead.—Galena is a good conductor, and may be directly electrolysed. The best bath is a solution of lead nitrate. The arborescent crystallisations extend rapidly, and must be broken from time to time to prevent the formation of a metallic connection between the anode and the cathode. The sulphur of the galena falls to the bottom of the bath, and may be separated from the gangue by solution in carbon disulphide. 3. Copper.—Native copper sulphide, though a good conductor, cannot be directly electrolysed on account of the presence of iron sulphide, whence iron would be deposited along with the copper. The copper pyrites are roasted, dissolved in dilute sulphuric acid, and the liquid thus obtained is submitted to electrolysis.

The Electrolytic Separation of Zinc.—B. Kossmann.—With one horse-power, 8 kilos. of zinc are separated in twelve hours. Sometimes plates of brass are used as cathodes. The metal obtained contains a trace of iron. A number of poor calamines can be treated by this method which have been hitherto useless.

Utilisation of Burnt Pyrites.—J. Creutz.—See p. 62.

List of Patents.—A number of patent specifications, chiefly English and German, relating to metallurgy and chemical manufactures.

Industrial Conversion of Oleic Acid into Palmitic Acid.—W. Lant Carpenter.—From the *Journal of the Society of Chemical Industry*.

Extraction of Glycerin.—F. Bang recommends the use of distilled water, and in general of materials all previously purified.

Precipitation of Calcium Saccharate.—P. Degener.—The author has studied the influence of the alkaline and earthy-alkaline chlorides in the precipitation of calcium saccharate at a boil.

Alteration of Caoutchouc by Air.—C. A. Burghardt.—From the *Journal of the Society of Chemical Industry*.

The Injurious Influence of the Fumes of Metallurgical and Chemical Works upon Vegetation.—J. V. Schrœder and C. Reuss.—Insoluble metallic particles deposited on the leaves of trees are generally harmless. Soluble mineral matter, *e.g.*, arsenious acid, is hurtful only when in a concentrated state. Insoluble compounds of lead, copper, and zinc in the soil are not hurtful except

their proportion is exceptionally large. Soluble metallic compounds are injurious. One-tenth per cent of As renders a soil barren. The mineral acids do not act injuriously in the soil, but in the air they are destructive even in minimal proportions. Hydrochloric acid gas is less to be dreaded than sulphurous acid.

Influence of the Manufacture of Soda by the Ammonia Process upon the Value of Hydrochloric Acid and Chlorine.—Walter Weldon.—From the *Journal of the Soc. Chem. Industry.*

German Patents relating to Colouring-Matters.—A catalogue of specifications.

Lectures on Solid and Liquid Illuminating Agents, delivered before the Society of Arts.—L. Field.—From the *Journal of the Society of Arts.*

Review of Chemical Investigations published Abroad.—Abstracts of memoirs from the *Berichte der Deutsch. Chem. Gesellschaft.*

Introduction to the Study of Chemistry. — E. Grimaux.— An extract from a lecture delivered at the Ecole Polytechnique on the advantages of the atomic theory.

Constitution of Chloride of Lime.—L. T. O'Shea.—From the *Journal of the Chemical Society.*

Industrial Society of Mulhouse.—Meeting of the Chemical Section, November 14, 1883.—M. Bourcart read a paper on the direct method of indigo-printing invented by MM. Schlieper and Baum.

M. Noelting has undertaken a series of researches on the law of substitutions in the azo-compounds. He announced also that by means of bromine, aniline and toluidine may be very accurately determined in their salts, or in their aqueous or acid solutions.

Journal für Praktische Chemie.
New Series, Vol. xxviii., Parts 18 and 19, 1883.

Carbonyl-diphenyl-oxide and Oxy-diphenylen-ketone, two Ketones formed from Salicylic Acid, and their Derivatives.—R. Richter.—See p. 63.

An Exhaustion-funnel heated with Steam and an Arrangement for cooling Surfaces for Sublimation.—R. Richter.—The arrangements in question cannot be intelligibly described without the accompanying illustration.

The Elementary Composition of Wheat-starch, and the Action of Dilute Acetic Acid upon Farina.—L. Schulze.—If starch is treated under pressure with acetic acid of a medium concentration for four hours, there is obtained a solution which gives with iodine a red colouration, and with alcohol a white precipitate. It reduces Fehling's solution only to a very slight extent, and possesses a somewhat considerable rotatory power. If purified it is found to be the dextrine α, described by Bondonneau. If the action of the acetic acid is prolonged the rotatory power of the product decreases, whilst its reductive power increases, the dextrine α being gradually converted into glucose.

Magnesium Bromide and Iodide.—Otto Lerch.—The author has obtained and described these compounds both in the anhydrous and the hydrated conditions; also the double bromides of magnesium and potassium, magnesium and ammonium, and the corresponding double iodides.

Chemico-critical Passages.—H. Kolbe.—A very sharp critique of the "Manual of Organic Chemistry," of Prof. Wislicenus.

A New Method of Preparing Phosphorus Oxychloride.—E. Dervin.—Potassium chlorate, dry and in fine powder, is added in small successive portions to phosphorus tri-chloride. The yield is 97 per cent of the theoretical quantity.

Alleged Transformation of Brucine into Strychnine.—M. Hanriot.—From *Comptes Rendus*, xcvii., p. 267, under which it has been noticed.

Justus Liebig's Annalen der Chemie,
Vol. 222, Part 1.

Communications from the Physical-Chemical Laboratory of the University of Leipzig.—These consist of a memoir by A. Hantzsch on the condensation-products of acetacetic ether; a paper by M. Pröpper on the action of fuming nitric acid upon acetacetic ether and its chlorine substitution-products, and remarks by A. Hantzsch on the last communication.

Substituted Benzoic Acids and the Nature of the Hydrogen Atoms in Benzol.—H. Hübner.—The first part of a voluminous dissertation, incapable of useful abridgment.

The Action of Sulphuryl-chloride upon Secondary Amine Bases.—R. Behrend.—The author describes tetra-methyl-sulphamide, dimethyl-amido-sulphuryl-chloride; its behaviour with dimethylamine; the action of gaseous hydrochloric acid upon tetra-methyl-sulphamide, dimethyl-diethyl-sulphamide, non-symmetrical dimethyl-sulphamide, dimethyl-phenyl-sulphamide, dimethyl-para-tolyl-sulphamide, dimethyl-sulphaminic acid, and its corresponding ether; diethyl-amido-sulphuryl-chloride, tetra-ethyl-sulphamide, and diethyl-dimethyl-sulphamide.

Bulletin de la Société Chimique de Paris.
No. 11 and 12, December 20, 1883.

Perfect Elasticity of Chemically Definite Solids. New Analogy between Solids, Liquids, and Gases.—W. Spring.—The author asks in the first place what is the cause of the different specific gravities of one and the same metal according as it has been cast, rolled, drawn into wire, or hammered? Does the difference observed prove a real condensation of the matter under the action of pressure, or is it merely due to the expulsion by pressure of gases which have been occluded when the ingot was cast? According to well-known researches metals such as platinum, gold, silver, and copper, which have been proved to occlude gases on fusion, and to let them escape, *incompletely*, on solidification, are precisely those which are most increased in their specific gravity by pressure. The author has submitted to pressures of about 20,000 atmospheres, metals which possess this property, either not at all, or to a very trifling extent, and he finds that though a first pressure produces a slight permanent increase of density, its repetition makes little difference. Their density is found to have reached a maximum. Hence the density of solids, like that of liquids, is only really modified by temperature. Pressure effects no permanent condensation of solid bodies, except they are capable of assuming an allotropic condition of greater density. The author's former researches tend to show that solid matter, in suitable conditions of temperature, takes the state corresponding to the volume which it is compelled to occupy. Hence there is an analogy between the allotropic states of certain solids and the different states of aggregation of matter. Possibly the different forms of matter may be due to a single cause, polymerisation. The limit of elasticity of a solid body is the critical moment when the matter begins to flow under the action of the pressure to which it is submitted, just as, *e.g.*, ice at or below 0°, may be liquefied by strong pressure. A brittle body is simply one which does not possess the property of flowing under the action of pressure.

The Action of Pressure on Solids in the State of Powder.—W. Spring.—A reply to the criticisms of MM. Friedel, Jannettaz, Neel, and Clermont (see *Bulletin de la Soc. Chimique*, vol. xxxix., p. 626, and vol. xl., p. 51).

Observations on the Experiments of M. W. Spring concerning the Action of Pressure on Solid Bodies in the State of Powder.—C. Friedel.—The author con-

siders that it may be effected by simple pressure, but doubts that it has really occurred hitherto.

MISCELLANEOUS.

The New Sibthorpian Professorship of Rural Economy.—Dr. Joseph Henry Gilbert, F.R.S., who has just been elected to the new Sibthorpian Professorship of Rural Economy at Oxford, in accordance with a scheme for its regulation sanctioned by the Chancery Division of the High Court of Justice, July 24th, 1883, studied chemistry at Giessen, under Baron Liebig, and took there the degree of Ph.D. Dr. Gilbert, who has long been a recognised leader in scientific agriculture, was elected a Fellow of the Royal Society in 1860, and served the office of President of the Chemical Society, and had the honour being elected a corresponding member of the Institute of France. The new professor will be required to lecture and give instruction on the scientific principles of agriculture and forestry. The electors were the Vice-Chancellor, the Sherardian Professor of Botany, the Professor of Geology, the Waynflete Professor of Chemistry, the President of the Royal Society, and the President of the Linnæan Society. The stipend of the new professor is £200 per annum, and the office is tenable for three years, for which period he may be re-elected on the termination of the time. The professor is required to give not less than twelve lectures in the course of the academical year in full term, but will not be allowed to give more than two in any one week.

Waterproof Paper and Pasteboard.—These articles are produced by treating the surface of ordinary paper with an ammoniacal solution of copper, so as partially to dissolve the surface, which is then let dry. Paper thus prepared is said to be equal in strength to parchment.—*Cosmos les Mondes*.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Steatite.—Would you kindly inform me, through the medium of your journal, where I am likely to find a market for New Zealand steatite or soapstone, and its value per ton in England?—ENQUIRER.

MEETINGS FOR THE WEEK

MONDAY, Feb. 11th.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "Recent Improvements in Photo-Mechanical Printing Methods," by T. Bolas, F.C.S.

TUESDAY, 12th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8. (Anniversary.)
— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.
— Society of Arts, 8. "The Portuguese Colonies of West Africa, by H. H. Johnston.

WEDNESDAY, 13th.—Society of Arts, 8. "New Process of Permanent Mural Painting, invented by Adolph Keim, of Munich," by Rev. J. A. Rivington.
— Microscopical, 8. (Anniversary.)

THURSDAY, 14th.—Royal, 4.30.
— Philosophical Club, 6.30
— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
— London Institution, 7.

FRIDAY, 15th.—Royal Institution, 8. "The Chemical Work of Wohler," by Prof. Thorp, at 9.
— Society of Arts, 8. "State Monopoly of Railways in India, by J. M. Maclean.
— Geological, 1. (Anniversary.)

SATURDAY, 16th.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1264.

ON THE CONDUCT OF MOIST PHOSPHORUS AND AIR TOWARDS CARBON MONOXIDE.

By ALBERT R. LEEDS.

IN the CHEMICAL NEWS, vol. xlviii., p. 199, will be found in full the article by Remsen and Keiser, to which I have alluded in my foregoing paper upon the "Conversion of Carbon Monoxide to Carbon Dioxide by Active Oxygen." Since both of these papers have appeared, a third, entitled "Contributions to a Knowledge of Active Oxygen," has been published in the *Berlin Berichte*, xvi., 2146, by Prof. Baumann, in which the results of repeating the experiments with carbon monoxide are given. The apparatus was constructed entirely of glass, and as the result of passing much larger volumes of purified air and carbon monoxide over moist phosphorus than I employed, correspondingly larger amounts of carbon dioxide were obtained. In one trial, after 700 c.c.m. CO, largely diluted with air, were passed through the activating chamber for fifteen hours, 36·6 m.grms.CO_2 were formed. In another experiment, 30 litres of air, containing 2·45 litres CO, yielded 64·6 m.grms. CO_2. In the latter case, 41 m.grms. CO, or 1·3 per cent of the entire amount of CO employed, had undergone oxidation.

AN IMPROVED FORM OF ORSAT'S APPARATUS FOR THE ESTIMATION OF OXYGEN.

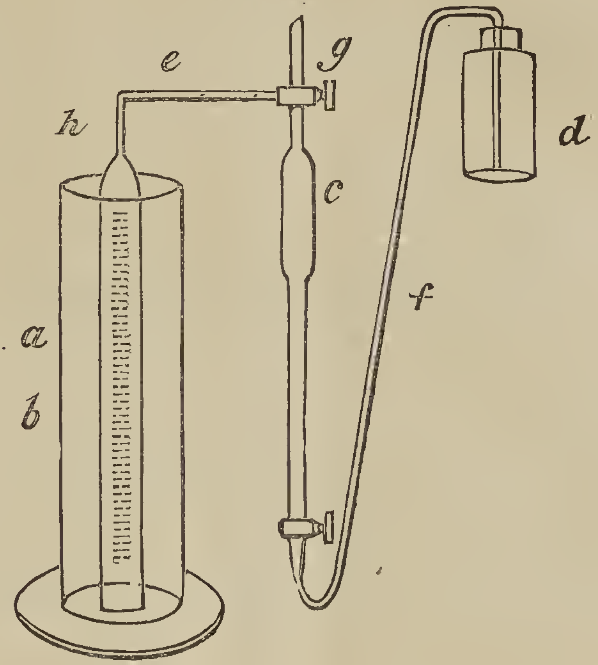
By J. B. C. KERSHAW.

THE usual form of Orsat's apparatus used for the estimation of oxygen in mixed gases would be a very satisfactory piece of apparatus were it not for one grave defect, and that is, that the results are not accurate.

This inaccuracy is not owing to any defect in the absorbing solution, but arises from an error in the measurement of the gas. The form of apparatus generally used is shown in Fig. 1. The glass tube, *a*, contains the Cu gauze, and stands in the cylinder *b*, which contains the ammonium chloride solution. *a* is connected to the gas burette, *c*, by *e*. *d* is a bottle containing water, connected to *c* by the india-rubber tube, *f*.

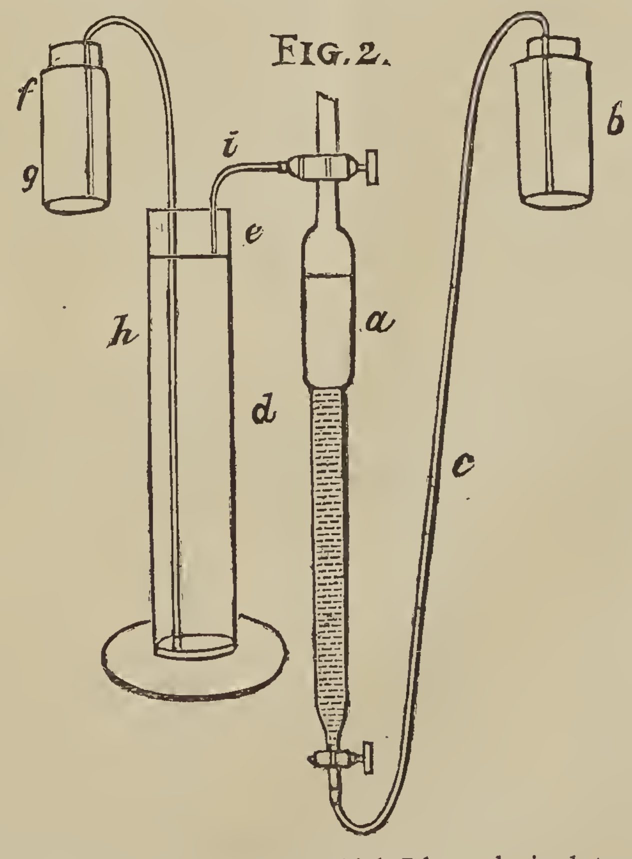
The method of working is as follows:—100 volumes of the gas to be tested are measured in *c*, and then the three-way cock, *g*, being turned so as to connect *c* with *a*, the bottle *d* is raised, and the gas forced over into *a*. As the Cu solution is forced out of *a* it rises in *b*, and on this account room must always be left in *b* for at least 100 c.c. more when the Cu solution is first put in. After remaining some minutes in *a* the gas is drawn back into *c*, and the loss is taken as the per cent of oxygen. Now the defect is this, that owing to the different levels of the Cu solution in *a* and outside *a*, the gas when measured the second time (after absorption) is at a greater tension than when first measured, and this causes an error of from 1 to 2 per cent in the results. The amount of error of course depends upon the difference in level between the solution in *b* and the fixed mark *h*,; the greater this difference the greater will be the the error, and *vice versa*. Anyone who uses this form of apparatus may satisfy themselves as to the existence of this error, by noticing the Cu solution drop from the mark, *h*, in *a*, when the stopcock, *g*, is turned so as to connect *a* and *c* (*c* being filled with gas measured at the normal pressure). The amount of error may be roughly determined by drawing the Cu solution up to the mark, *h*, and noticing the increase in volume; the increase was 2 c.c. with the apparatus with which I experimented, but it of course differs in every one. To overcome this defect it is evident that the Cu solution must be level with *h* in the outside cylinder, *b*, when *a* is filled up

FIG 1



to the same mark. Now, with this form of apparatus this is impossible, as some room (100 c.c. at least) must always be left in *b* to hold the solution forced out of *a* by the incoming gas.

FIG. 2.



The form of apparatus which I have devised to overcome this defect is shown in Fig. 2.

a is the gas burette connected to the bottle, *b*, containing the water for manipulating the gas by the india-rubber tube, *c*. *d* is a cylindrical glass jar about 12 inches long,

and 1½ inches diameter, filled with a roll of Cu gauze, which should extend quite up to the cork, *e*. *f* is a bottle containing the NH_4Cl solution connected to the cylinder, *d*, by the tubes *g* and *h*. *d* is connected to *a* by means of a short piece of tube of very narrow bore, bent at right angles. The cork, *e*, must fit very tightly into *d*, and for this reason a cylinder with very thick sides must be chosen, as the pressure exerted by the cork is liable to break a thinner one. The method of working is as follows:—

The bottle, *f*, is fixed at such a level that the solution in *d* just rises to the fixed mark on *i*, when the stopcock, *j*, is turned so as to connect *d* with the air. 100 vols. of the gas to be tested are then measured in *a*, and forced over into *d* by means of the water in *b*; to accelerate the passage of the gas from *a* to *d*, *f* may be lowered so as to act as a syphon. After remaining in *d* a few minutes the gas is transferred back to *a*, by restoring *f* to its original position and lowering *b*. The loss will represent the per cent of O.

With this form of apparatus no error arising from difference of levels can possibly occur, as the solution in *f* can always be kept exactly level with the fixed mark on *i*, either by raising or lowering the bottle, *f*, or by adding to or taking from the solution in *f*. This apparatus is most convenient mounted on a retort stand. Two of the rings cut to the required size serve for supporting the burette, *a*, whilst the others covered with round pieces of wood will hold the cylinder, *d*, and the two bottles, *b* and *f*, in the required positions.

The slight error due to the absorption of the gas by the water used to manipulate it, may be obviated by covering the surface of the water in the burette with a thin layer of oil.

SPEED OF DISSOCIATION OF BRASS.*

By ROBERT B. WARDER.

The following determinations, which were suggested by Bobierre's† method for the separation of copper and zinc in alloys, were made by Mr. E. Twitchell.

A piece of brass wire, No. 17, 150 m.m. long and 1·43 m.m. in diameter, was heated to redness in a stream of hydrogen, in a porcelain tube, over a gas combustion furnace. The weight was taken from time to time, to determine the rate at which the zinc was volatilised. If the expulsion of zinc at each moment is proportional to the whole quantity of zinc then present in the alloy, we may assume—

$$\log. \frac{u_0}{u} = At.$$

where u is the weight of zinc present at the end of the time, t; u_0 is the initial value of u; and A is a constant, depending upon the temperature, surface, &c. To apply this criterion,‡ the values of 1000 A are given in the table. A direct determination gave 36·02 per cent of zinc in the brass used.

Time in Hours.	Weight of Alloy.	Loss per Hour.	Zinc present.	1000 A.
0	2·0570		0·7409	
1	1·9128	0·1442	0·5967	92
2	1·8527	0·0601	0·5366	70
3	1·7855	0·0672	0·4694	66
4	1·7418	0·0437	0·4257	60
5	1·7168	0·0250	0·4007	53
6	1·6957	0·0211	0·3796	48
9	1·6624	0·0111	0·3463	37
12	1·6339	0·0095	0·3178	31

The steady decrease in the last column shows that the formula used does not apply to the observations recorded, but that the rate of loss diminishes much more rapidly than the whole quantity of zinc present. This may also be seen by direct inspection of the third and fourth columns. Whatever relation may hold between the rate of loss and the quantity of zinc at the surface, we may suppose that the zinc in the body of the cylinder is transmitted toward the surface by a slow process of diffusion.*

Further experiments are proposed.

* Read before the Section of Chemistry and Physics of the Ohio Mechanics' Institute, May 31, 1883.

† *Comptes Rendus*, xxxvi., 224, 736 (1853). *Journ. f. Prakt. Chem.*, lviii., 380 (1853). "Fresenius's Quantitative Analysis," last American edition, p. 542.

‡ *Scientific Proceedings of the Ohio Mechanics' Institute*, i., 166-170.

* Colson has studied the diffusion of iron and carbon and some other solids; *Comptes Rendus*, xciii., 1074 and xciv., 26 (1882); abstracts in *Chem. Soc. Journ.*, xlii., 454, 357.

COAL-GAS AS A LABOUR-SAVING AGENT IN MECHANICAL TRADES.†

By THOMAS FLETCHER, F.C.S.

Gas, as a fuel, is an absolute necessity to the economical carrying out of many commercial processes. It is often used in the crudest and most costly way; a burner may be perfect for one purpose, yet exceedingly wasteful for another, and however good it may be, an error of judgment in its application may lead to its total condemnation. An excess of chimney draught, in cases where a flue is necessary, may pull in sufficient excess of cold air to almost neutralise the whole power of the burner, unless a damper is used with judgment. With solid fuel, an excess of draught causes more fuel to be burnt, but with gas, the fuel is adjusted and limited; there is no margin or store of fuel ready to combine with the excess of air, which, therefore, lowers the amount of work done by its cooling power. The power of any burner, for any specified purpose, depends not only on its perfection, but to a far greater extent on the difference in the temperature of the flame, and of the object to be heated. For instance, if a bright red-heat is required, it is not possible to obtain this temperature economically with any burner working without an artificial blast of air, the difference between the temperature of the flame and that of the object heated is too little to enable the heat to be taken up freely or quickly, and the result is a large loss of costly fuel. If we want to obtain high temperatures economically, an artificial blast of air is necessary, and the heavier the pressure of air, the greater the economy. On the contrary, low temperatures and diffused heat are obtained best by flames without any artificial air supply.

For such purposes as ovens, disinfecting chambers, japanners' stoves, founders' core drying, and similar requirements, the best results are obtained by a number of separate jets of flame at the lowest part of the enclosed space, and the use of either illuminating or blue flames is a matter of no importance, as the total amount of heated air from either character of flame is the same. If there is any preference, it may be given to illuminating flames, as the proportion of radiant heat is greater, and this makes the average temperature of the enclosed space more equal; but, on the other hand, may be considered the greater liability of the very fine holes, necessary for illuminating flames, to be choked with dust and dirt. This may, to a great extent, be obviated by using very small union jets, and setting them horizontally, so as to make a flat horizontal sheet of flame. Burners placed this way are practically safe from the interference of falling dust or dirt, but not from splashes. Falling dirt or splashes must always be considered in the arrangement of any burners, and the ventilation must be no greater than is absolutely necessary for the required work. In cooking, this limit of ventilation may be exceeded, as most things are better cooked with a free ventilation, the extra cost of fuel being well compensated for by the better quality of the result.

The air in an oven or enclosed space heated by flames

† A paper read before the Society of Arts, January 30, 1884.

inside is similar in character to highly superheated steam. It contains a large proportion of moisture, and yet has the power of drying any substance which is heated to near its own temperature. A mass of cold metal placed in the oven is instantly bedewed with moisture, which dries up as the temperature of the metal rises. This is, for many purposes, an objection, and the remedy is to close the bottom of the oven and place burners underneath. If for drying purposes, and a current of air is necessary, the simplest way is to place in the bottom of the oven a number of tubes hanging downwards in such a position that the heat of the flame acts both on the bottom of the oven and the sides of the tubes, which, of course, must be long enough for the lower opening to be well below the level of the flame. The exit may be at any level, but for drying purposes it is better at the top, and it should be controlled by a damper to prevent cooling by excessive currents of air. If not otherwise objectionable, the arrangement of flames inside the oven is far the most economical in use.

Where an oven or drying chamber is used continuously it should be jacketted with slag wool or boiler composition, but for many purposes this is no advantage. As an example both ways, I will instance the drying of founders' cores, where there is only one blow per day. The cores of an ordinary foundry can be dried by gas in a common sheet-iron oven in about half-an-hour; any accumulation of heat after that time would be useless, and a jacketted oven would be of no advantage.

For the disinfection of clothes in vagrant wards and hospitals for infectious diseases, on the contrary, a continued heat is necessary, and in this case the accumulation of reserve heat, which takes place slowly in a jacketted oven, becomes of value, as the gas can be turned low or out, and the ventilators closed, ensuring a more complete disinfection with a much smaller gas consumption. Where an oven or heated chamber is much used for periods of over half-an-hour at once, a non-conducting casing pays well by reduced gas consumption.

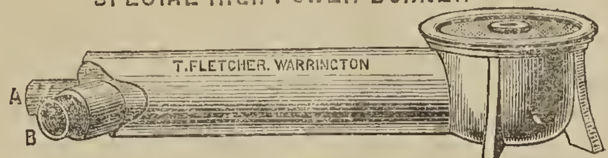
For albumen and glue drying, leather enamelling, tobacco drying, and purposes where a large space has to be very slightly and equally warmed when the weather is unfavourable, steam-pipes are generally used, but, not being always available, an exceedingly good arrangement may be made by placing at intervals in the room gas burners, of any construction, close to the floor, and surrounded with a sheet-iron cylinder, say 2 ft. or 3 ft. high. The top of these cylinders must be connected throughout with a fairly large flue, which will take the products of combustion from the whole, and this flue must be carried either horizontally, or with a slight rise, so as to utilise all the waste heat. The reason for having a number of stoves at intervals is that the heat in a flue will not carry for any useful purpose more than about 8 ft. or 10 ft., and a single stove would give an irregular temperature in any except a very small room. If all are not used at once, the flues of those not in use may be closed by a damper to prevent down draught. The use of hot-water pipes heated by gas may also be occasionally advisable, but, unless for some special reason, it is much more economical to use coal or coke, as the bulk of water makes an exceeding good regulator, and makes a fire practically as steady and reliable as gas, thus superseding the more costly fuel.

For one of my own purposes I need hot-water pipes, having very little variation in temperature night and day, and using coke for economy's sake, I get a regular temperature by heating a large quantity of water, about 200 gals., with the fire, and enclosing this in a tank jacketted with slag wool. My circulating pipes run from this tank, and a practically steady temperature, night and day, can be obtained with the most irregular firing, and occasional extinction of the fire for several hours at once.

For the heating of liquids, the greatest economy is to be obtained from one single flame, of as high a temperature as can conveniently be obtained, and the flame must be in actual contact with the vessel to be heated. In jacketting vessels, to prevent draughts, care must be taken that the jackets do not cause currents of cold air to rise rapidly up the sides of the vessel, and so cool it. If this is the case, the use of a jacket, instead of being an economy, is a positive expense, and waste of heat. Many processes, such as making oil and turpentine varnishes, require a heat under instant control, and in these, the use of a gas is an important matter, as the loss and risk of fire are very serious elements of expense, more especially in small works where special and costly preparations for contingencies cannot be afforded. I have here a burner

Fig. 1.

SPECIAL HIGH POWER BURNER



SHEWING ATTACHMENT B WHEN USED WITH A BLAST OF AIR

which, for its power, is, perhaps, the most compact, and gives the highest temperature of any burner yet known, and it is easily made in almost any size; it has, I think, many special advantages. The use of gauze, which is its only weak point, is more than compensated for by the very high duties obtained in practice with it, owing to the compactness and concentration of the heat obtained. The following extract from my communication to the Gas Institute will give all particulars as to the constructive detail of this burner. Those who wish to go further into the matter will find the paper referred to in the publication of the Gas Institute for the current year, and also in the *Journal of Gas Lighting*, June 26th, 1883, and the *Review of Gas and Water Engineering*, June 16th, 1883.

"The first and most important part is the mixing chamber or tube, one end of which is supplied separately with gas and air, which at the other end are, or should be, delivered as a perfect mixture. It may be taken as a rule that this tube, if horizontal, should not be less in length than four-and-a-half times, or more than six times, its diameter. It is a common practice to diminish or make conical-shaped tubes. All my experience goes to prove that, excepting a very trifling allowance for friction, the area of the smallest part of the tube rules the power, the value of the mixing tube being no more than that of the smallest part. If the mixing-tube is upright new sources of interference come in; notably the varying specific gravity of the mixture. Except with one definite gas supply, the result is always more or less imperfect, and regular proportions cannot be obtained. This is now so well known that the upright form has been practically discarded for many years, and is now only used where the peculiar necessities of the case give some special advantage.

"The diameter of the mixing-tube is a matter of importance, as it rules the quantity of gas which can be satisfactorily burnt in any arrangement. With large flames, given a certain size of gas-jet, the diameter of the mixing-tube should be not less than ten times as great. For instance, at 1 inch pressure, a jet having a bore of 1-8th inch will pass about 20 cubic feet of gas per hour. To burn this quantity of gas, a mixing-tube is necessary, 10-8ths or $1\frac{1}{4}$ inch in diameter. By the first rule this tube must be in length equal to four-and-a-half times its diameter, or $5\frac{5}{8}$ inches. It would appear that the mixing-tube, having 100 times the area of the gas-jet, is out of all proportion to the size necessary for obtaining a mixture of one of gas to nine or ten of air; but it must be remembered that the gas is supplied under pressure. It is therefore evident that no mere calculation of areas can be taken into account, unless the difference in pressure of the supply is also considered. A complete reversal of this law is shown in that ruling the construction of blowpipes, which I have already given in a previous paper on "The

Use and Construction of the Blowpipe." In these, the air supply, being under a heavier pressure, is much smaller in area than the gas inlet; and, to obtain maximum power, the air-jet requires to be enlarged in proportion to the gas pressure.

"Given a certain area of tube delivering a combustible mixture, the outlet for this mixture must be neither more nor less than the size of the tube. Taking an ordinary drilled tube, such as is commonly made, and of the dimensions before given—*i. e.*, $1\frac{1}{4}$ inch bore—if the holes are drilled $\frac{1}{8}$ inch in diameter the tube will supply $10\times 10=100$ of these holes. In practice this rule may be modified.

"The variations from the rule, however, must be a matter of experience with each form of burner. There is also the fact that with small divided flames it is not necessary to mix so large a proportion of air, as each flame will take up air, on its external surface; but in this case the flames are longer, hollow, and of lower temperature. As a matter of actual practice, where a burner is used which gives a number of flames or jets, the diameter of the mixing-tube does not need to exceed eight times the diameter of the gas jet; the remainder of the air required being taken up by the surfaces of the flames.

"Wire gauze, made of wire the thickness of 22 iron wire gauge, 20 wires to the linear inch, and tinned after weaving, has an area in the holes of 1-4th its surface. By calculation, the area of a gauze surface in a burner should, therefore, he taken at four times that of the tube, and our standard of $1\frac{1}{4}$ inch tubes requires a gauze surface of $2\frac{1}{2}$ inches in diameter. This rule is subject to variation in burners of a small size, owing to the air that can, if required, be taken up by the external surface of the flame, which, of course, is much greater in proportion in a small flame than in a large one. Where the diameter of the gauze is, say, not over one or two inches, the theoretical maximum gas supply may be exceeded, and a varying compensation is necessary with each size. My rule is intended to supply to burners of larger diameters, where the external air supply plays a comparatively unimportant part.

"It must be remembered that burners of this class, which burn without the necessity of an external air supply in a flame which is solid, require the mixture to be correct in proportions. A very slight variation makes an imperfect flame. Not only does the gas-jet require to be adjusted with great precision, but it also needs more or less adjustment for different qualities of gas. An ordinary hollow or divided flame is able to take up on its surface any deficiency of air supply; but with the high-power solid flames the outside surface is small, and the consequence is that one of these burners, adjusted for gas of poor quality, may, when used with rich gas, give a long hollow or smoky flame, unless the gas-jet be reduced in size. When perfect, the flame shows a film of green on the surface of the gauze; and if a richer gas is used, the green film lifts away. To cause this to fall again, and to produce a solid flame, it is necessary to take out the gas-jet and tap the end with a hammer until, on trial, it is found correct. If too small, the green film lies so closely as to make the gauze red-hot. Where the 'tailing up' of the carbonic oxide flame is objectionable, there is no practical difficulty whatever in constructing these burners as a ring, with an air supply in the centre, which greatly reduces the length of the 'tail.' In practice it is a decided advantage to have a centre air-way in all burners of more than about 2-inch diameter, as it enables the injecting tube to be slightly shortened, and lessens the liability of the green film to lift with varying qualities of gas. In this class of burner I have adopted the small central air-way as a decided improvement in the burners."

(To be continued).

Iso-indol. — P. Friedlaender and J. Mähly.— The authors have obtained a compound which they regard as para-amido-α- or β-phenyl-amphi-nitril.—*Ber. d. Deutsch*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

COPPER.

The atomic weight of copper has been chiefly determined from the composition of the black oxide and the anhydrous sulphate. In dealing with the first named compound all experimenters have agreed in reducing it with a current of hydrogen, and weighing the metal thus set free.

The earliest experiments of any value were those of Berzelius,† whose results were as follows:—

		Per cent Cu in CuO.
7·68075 grms. CuO lost	1·55 grm. O.	79·820
9·6115 „	1·939 „	79·826
	Mean	79·823 ± 0·002

Erdmann and Marchand,‡ who come next in chronological order, corrected their results for weighing in air. Their weighings, thus corrected, give us the subjoined percentages of metal in CuO:—

63·8962 grms. CuO gave	51·0391 Cu.	79·878 per cent.
65·1590 „	52·0363 „	79·860 „
60·2878 „	48·1540 „	79·874 „
46·2700 „	36·9449 „	79·846 „
	Mean	79·8645 ± 0·0038

Still later we find a few analyses by Millon and Commaille.‖ These chemists not only reduce the oxide by hydrogen, but they also weighed, in addition to the metallic copper, the water formed in the experiments. In three determinations the results were as follows:—

Grms.	Grms.	Grms.	Per cent.
6·7145 CuO gave	5·3565 Cu and	1·5325 H_2O.	79·775
3·3945 „	2·7085 „	0·7680 „	79·791
2·7880 „	2·2240 grms. Cu.		79·770
		Mean	79·7787 ± 0·0043

For the third of these analyses the water estimation was not made, but for the other two it yielded results which, in the mean, would make the atomic weight of copper 63·087, ± 0·222. This figure has so high a probable error that we need not consider it further.

The results obtained by Dumas§ are wholly unavailable. Indeed, he does not even publish them in detail. He merely says that he reduced copper oxide, and also effected the synthesis of the subsulphide, but without getting figures which were wholly concordant. He puts Cu = 63·5.

Latest of all, and probably the best also, we have the determinations by Hampe.¶ First, he attempted to estimate the atomic weight of copper by the quantity of silver which the pure metal could precipitate from its solutions. This attempt failed to give satisfactory results, and he fell back upon the old method of reducing the oxide. From 10 to 20 grms. of material were taken in each experiment, and the weights were reduced to a vacuum standard:—

20·3260 grms. CuO gave	16·2279 Cu.	79·838 per cent.
20·68851 „	16·51669 „	79·835 „
10·10793 „	8·06926 „	79·831 „
	Mean	79·8347 ± 0·0013

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 177.
‡ *Journ. f. Prakt. Chem.*, 31, 389. 1844.
‖ *Fresenius's Zeitschrift*, 2, 475. 1863.
§ *Ann. d. Chim. et Phys.*, (3), 55, 129.
¶ *Fresenius's Zeitschrift*, 13, 352.

Hampe also determined the quantity of copper in the anhydrous sulphate, $CuSO_4$. From 40 to 45 grms. of the salt were taken at a time, the metal was thrown down by electrolysis, and the weights were all corrected. I subjoin the results:—

40·40300 grms. $CuSO_4$ gave	16·04958	grms. Cu,	39·724
44·64280 ,,	17·73466	,,	39·726
		Mean	39·725
			± 0·0007

We now have four series of experiments upon copper oxide, as follows:—

Berzelius..	79·823	± 0·0020
Erdmann and Marchand ..	79·8645	0·0038
Millon and Commaille.. ..	79·7787	0·0043
Hampe	79·8347	0·0013
General mean	79·830	0·0010

For copper we have—

From composition of CuO ..	Cu = 63·181	± 0·036
,, $CuSO_4$ (Hampe)	,, 63·171	0·012
General mean	,, 63·173	0·011

If O = 16, then Cu becomes = 63·318.

The close agreement between the two independent values for Cu is certainly very striking. It will be seen that Hampe's two estimates upon the sulphate carry (perhaps accidentally) much greater weight than all the experiments upon the oxide. This might seem like giving them undue credit, were it not for the fact of the remarkable concordance of the results above referred to. Either estimate for Cu would be valid without the other.

The following additional note has been communicated by the author:—

Since the foregoing chapter was published, Baubigny has printed some new data.* Two calcinations of pure $CuSO_4$ give, in mean, a residue of 49·810 per cent of CuO. Hence Cu = 63·306. If SO_3 = 80, this value becomes 63·394.

* Compt. Rend., 97, 906.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 7, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE PRESIDENT announced that a ballot for the election of Fellows would take place at the next meeting of the Society (February 21).

The following certificates were read for the first time:— F. W. Brown, J. E. London, G. A. Parkinson, G. Tunbridge, T. U. Walton.

The SECRETARY then read a paper, "*On the Expansion of Liquids*," by D. MENDELEJEFF, translated from the Russian by B. BRAUNER. Though every liquid has its own peculiar coefficient of expansion, a general expression for the expansion of all liquids has long been a desideratum. The generalisation now given by the author is founded on the additional experimental material collected by chemists chiefly for the purpose of studying the specific volumes of liquids at their boiling temperatures. In the present paper only the physical side of the question is discussed. Most of the data are derived from Thorpe's paper (*Chem. Soc. Journ. Trans.*, 1880, 141). The uniformity in the expansion of liquids shown by the examples given in numerous tables may be represented by the formula—

$$V = \left(1 + \frac{k}{n} t\right)^n$$

which is the same as that giving (according to Gay-Lussac's law) the expansion of gases. For gases $n = +1$; for liquids $n = -1$. The expression for liquids becomes, therefore,—

$$V = (1 - kt)^{-1} = \frac{1}{1 - kt},$$

and as the specific gravities are inversely proportional, if D = density at t, and Do the density at 0°, then—

$$D = Do(1 - kt).$$

The author then gives several examples of the close agreement obtained with the above formula, and the experimental results of Thorpe. Thus, with phosphorus tribromide, according to Thorpe:—

t =	40°	60°	80°	100°	120°	140°
V =	1·0348	1·0530	1·0720	1·0916	1·1123	1·1340
V calculated—	1·0348	1·0531	1·0721	1·0918	1·1123	1·1325

(k = 0·000841)

The author discusses the varying values of k, in the exceptional case of water at different temperatures. The results of the paper may be summed up as follows:—In the expansion of liquids a peculiar regularity and a qualitative uniformity is observed, and the equation given above may be taken as an approximation to reality, k being a constant coefficient characterising each liquid as the specific gravity, the boiling-point, &c. The author proposes to call k the determinator of expansion, and suggests that a determination of its value under different conditions is extremely important for the mechanics of liquids. The expression given above, although many liquids deviate slightly from it, is by itself sufficient in the majority of physico-chemical investigations just as Gay-Lussac's law is sufficient for most physico-chemical work with gases.

Dr. MORLEY said if the expression held with two liquids it ought to hold with mixtures. He examined some time back the expansion of hydrocarbon from petroleum, and found that k first increased, then decreased. Such a phenomenon could not be explained if the law was rigorously true.

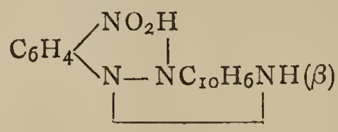
Dr. ARMSTRONG read an extract from a letter of Dr. Thorpe, who had seen the paper, in which he expressed his satisfaction that the physical data which he had been at some trouble to obtain should have formed the basis of such an important paper.

The PRESIDENT then called on Mr. R. MELDOLA to read a paper entitled "*Researches on Secondary and Tertiary Azo-Compounds, No. II.*" The author describes in this paper, in continuation of his former researches, the action of diazotised para-nitranilin upon tertiary monamines. In the case of dimethyl-anilin, the resulting product is para-nitro-benzen-azo-dimethyl-anilin,—

$$NO_2C_6H_4N_2C_6H_4NMe_2,$$

and this on reduction by ammonium sulphide furnishes the corresponding amido compound. The amido group in the latter is easily diazotised, and can be combined with phenols so as to form a new series of secondary azo-compounds. Para-amido-benzen-azo-dimethyl-anilin is a most delicate test for nitrous acid: when diazotised, and then neutralised with ammonia, a fine blue colour appears. By this test one part of sodium nitrite in 64,000 of water has been detected. The next portion of the paper deals with the action of diazotised meta-nitranilin upon primary, secondary, and tertiary monamines. The nitro-azo-compounds of the meta series could not be reduced by ammonium sulphide without complete decomposition, so that this method could not be applied for the preparation of secondary and tertiary azo.

compounds as in the para series. The β-naphthylamine compounds, both of para- and meta-nitro-diazo-benzene, cannot be further diazotised by the action of nitrous acid, but furnish nitroso-derivatives. From this fact the author concludes that an amido group is no longer present in these compounds, and assigns to them the constitutional formula—



A comparison of the melting-points of the β-compounds both of the para and meta series also favours the view that they are differently constituted to the true nitro-azo-compounds derived from α-naphthylamin.

Dr. Armstrong thought the constitution suggested by the author highly probable. He had noticed with the naphthols the very marked difference between the α and β bodies.

Mr. Meldola, in answer to several questions, said that all the bodies were more or less coloured, but the more complex the body became the duller the colour seemed to be. There seemed to be a tendency to become bluer as the complexity increased. The difference between the α and β compounds seemed to depend on the fact that the most readily displaced hydrogen atom in the latter compound was the contiguous ortho-atom, so that we were really dealing with an ortho compound.

The Secretary then read a communication entitled, "*Note on the Nitrogenous Matters in Grass and Ensilage from Grass,*" by E. Kinch. The object of the author was to determine whether, during the fermentations to which grass and other fodder crops are subjected in order to produce ensilage, the albumenoids undergo any change into other nitrogenous bodies not possessing the physiological functions of albumenoids; for, although the exact nutritive value of these non-albumenoid nitrogenous bodies is as yet unknown, it is certain that they can only replace the true albumenoids in food to a limited extent. The sample of grass was taken during the filling of the silo, on July 17, 1883. The grass was coarse, and contained notably thistles and *ranunculi*. It was passed through a chaff-cutting machine. The weight on the silo was about 50 lbs. per square foot. The ensilage was taken out on December 8; it was brown, scarcely acid, and had but little odour. It soon, however, developed a smell of acetic acid, which was subsequently replaced by that of butyric acid. It was readily eaten by cattle when mixed with dry fodder. The author gives detailed analyses of the grass and ensilage. The albumenoids were determined by the phenol, the copper hydrate, the mercuric hydrate, and the lead hydrate methods. The most striking change was in the relative quantities of the albumenoids and non-albumenoids. In the grass the non-albumenoids formed but 9 per cent of the total nitrogen; in the ensilage the non-albumenoids had increased to 55 per cent of the total nitrogen. So that during the fermentation in the silo nearly half the albumenoid nitrogen has been converted into non-albumenoid. Whether such changes in the nitrogenous matter always take place, or, as is likely, are diminished in extent by increasing the pressure to which the fodder is subjected, and what nitrogenous bodies are produced, are questions which the author hopes to answer in a future paper.

Prof. Church said that he had found it advantageous to add a little meta-phosphoric acid when employing his phenol process if the material was at all alkaline.

Mr. Vincent mentioned some experiments in which cows had been fed alternately on ordinary food and on ensilage. The weight of the cows remained constant, but when fed on ensilage the cows furnished on an average two gallons of milk more per diem. He also could confirm the fact that ensilage from clover has a most powerful odour of butyric acid.

Mr. Warington said that it was hardly possible to overrate the practical importance of ensilage. As far as he knew, Prof. Kinch had been the first to determine the relative quantities of albumenoid and non-albumenoid nitrogen in ensilage. There had been many analyses of grass and ensilage published, but no one yet had really made a quantitative experiment, *i.e.*, weighed all the grass which went in and the ensilage produced. We were also very much in want of analyses of foods as to the relative quantities of albumenoid and non-albumenoid nitrogen which they contained.

Mr. Friswell suggested that the experiment quoted as to the increase of quantity of the milk was of but little value unless the quality of the milk, as ascertained by analysis, was known.

Dr. Armstrong said it would have been interesting to know the quantity of nitrogen liberated by hypobromite.

Mr. Lloyd had endeavoured to investigate the form taken by the nitrogen, but had hitherto been unsuccessful. If too much pressure was used much nutritive juice was squeezed out of the grass. The great aim should be to avoid an acid fermentation.

The Secretary then read a paper "*On the Influence of the Temperature of Distillation on the Composition of Coal-gas,*" by L. T. Wright. The author distilled a carefully mixed sample of Newcastle coal in a small iron retort. The charge was 2·24 lbs., and the distillation occupied twenty-five to forty-five minutes. Four experiments were made at various temperatures. With the lowest temperature 8250 cubic feet of gas per ton of coal were obtained, of 20·5 candle-power. At the highest temperature 12,006 cub. ft.; ill. p. 15·6. The gas in the first case contained 38·09 per cent H, 8·72 CO, 42·72 CH_4, 7·55 other hydrocarbons, and 2·92 per cent N. The gas obtained at the highest temperature contained 48·02 p. c. H, 13·96 CO, 30·7 CH_4, 4·51 hydrocarbons, and 2·81 per cent N. The author discusses the influence of marsh-gas, carbonic oxide, &c., on the illuminating power of the gas, and criticises the experiments of Frankland and Thorne. In the second part of the paper the author gives some analyses of gas drawn from retorts at different stages of the ordinary process of gas manufacture. The results confirm those obtained by Dr. Henry.

Prof. Foster said that apparently no analysis of the coal was given. He also gave an account of some experiments which he had made of passing steam over coke, and thus liberating the nitrogen contained in it.

The Society then adjourned to February 21, when a ballot for the election of Fellows will be held.

PHYSICAL SOCIETY.

Annual General Meeting, Saturday, February 9, 1884.

Prof. Clifton, President, in the Chair.

The motion to make Past Presidents permanent Vice-Presidents was carried, and the Articles of the Society altered accordingly.

Prof. Clifton read a Report on the business of the past year, which showed that steady work had been done by the Society.

Dr. Atkinson read the Balance Sheet, showing a flourishing condition of the Society.

A proposal to adopt certain letters to indicate Membership of the Society when placed behind the name was, on the motion of Prof. G. Forbes, supported by Professors Adams, McLeod, and others, held in abeyance for the present.

The Officers and Council for the ensuing year were then elected, and were as follows:—

President—Prof. F. Guthrie, F.R.S.

Vice-Presidents—Profs. R. B. Clifton, F.R.S.; W. E. Ayrton, F.R.S.; W. Chandler Roberts, F.R.S.; Dr. J. Hopkinson, F.R.S.; Lord Rayleigh, F.R.S.

Secretaries—Prof. A. W. Reinold, M.A.; Mr. W. Baily, M.A.

Treasurer—Dr. E. Atkinson.

Demonstrator—Prof. F. Guthrie, F.R.S.

Other Members of Council—Mr. Shellford Bidwell, M.A., LL.B.; Mr. C. W. Cooke; Prof. F. Fuller; Mr. R. T. Glazebrook, F.R.S.; Mr. R. J. Lecky, F.R.A.S.; Prof. H. McLeod, F.R.S.; Dr. Hugo Müller, F.R.S.; Prof. J. Perry; Prof. S. P. Thompson.

Honorary Member—Prof. H. A. Rowland.

Prof. Clifton then resigned the Chair to Prof. Guthrie, whose zeal for the Society he warmly praised.

Prof. Guthrie expressed his high appreciation of the courtesy and kindness of the retiring President while in the Chair.

Mr. W. Lant Carpenter proposed a vote of thanks to the Lords of the Committee of Council on Education.

Mr. Whipple moved the cordial thanks of the Meeting to Prof. Clifton.

Mr. Griffith and Prof. Adams proposed a vote of thanks to the Secretaries, Demonstrator, and Treasurer.

Prof. G. C. Foster proposed a vote of thanks to the Auditors.

The Meeting was then resolved into an Ordinary one, and the Secretary read a paper by Dr. O. J. Lodge and J. W. Clark, on the "*Phenomena Exhibited by Dusty Air in the Neighbourhood of Strongly-illuminated Bodies.*" In 1870, Dr. Tyndall described the dark or dust-free plane rising from a hot body in illuminated dusty air. The authors discuss his and other explanations of the phenomena, and give reasons against them. They have observed that the plan is only a prolongation of a dust-free coat or layer of greater or less thickness round the body. They have experimented with the coat in various ways detailed in the paper, but the general conclusion is that it is produced by (1) a molecular bombardment, (2) gravitative settling. It exists when the body is warmer than the air. The results are similar to those of Mr. Aitken, communicated to the Royal Society of Edinburgh.

Prof. Forbes observed that Aitken shows that a room heated by a stove will have dustier walls than one heated by a fire, owing to the air being hotter than the walls.

Prof. S. P. Thompson stated that he had found an electric discharge from a point in dusty air cause vortices in the air; that air shot off by the discharge sometimes eddying round again to the point.

NOTICES OF BOOKS.

A Centenary of Science in Manchester. For the Hundredth Year of the Literary and Philosophical Society of Manchester (1881). By R. Angus Smith, Ph.D., LL.D., F.R.S., &c. London: Taylor and Francis. 1883.

Whatever may be the verdict that future generations will pass upon the doings of the human race of the nineteenth century—now in its last decade but one—the influence that experimental science applied to the arts has exercised on civilisation will form one of the most important factors that will have to be taken into consideration both by the politician and by the philosopher. However confident we may feel as to the immensity and variety of the wonders in Nature's storehouse yet to be brought to light by the efforts of future explorers, and of the illimitable cunning of the human intellect that may eclipse all our inventions and systems of philosophy and science, it must be admitted that the discoveries and advancements made during the present century are realities fit to be compared to the dreams of the ancient Orientalists, and such as would have petrified the sages of old Greece amidst their speculations.

The rise of the experimental method, which may be said to have taken place during the last hundred years, has given to society a new phase of intellect in the so-called scientific man, that phase of intellect characterised essentially as the sceptical, which requires to know the whys and the wherefores of phenomena, not resting satisfied with mere observation and conjecture. Our old seats of learning have until recently kept their doors closed against such men, under the belief partly that such studies had no humanising influence on character. There is probably a grain of truth in this supposition, for it may well be doubted if the study of dead matter does refine the sentiments or has any ennobling effect upon human nature, and whether the scientific man does not show traits in his character to be expected amongst some of the lower orders of untrained intellects.

As a retrospect of the science in Manchester for the last hundred years, to commemorate the centenary of the Literary and Philosophical Society in that city, Dr. Smith's work will be found to be of greater interest to the locality, and to those who have been and are connected with the Insitution, than to the scientific world at large. When, however, we consider that the history of the Society is intimately interwoven with the life-work of two men whose writings in its *Memoirs* have earned for the Society a world-wide renown, and that Manchester is now becoming one of the scientific centres of this country, it will be of some interest to give a short sketch of this Society, of which some of its members have played so important a part in the advancement of science.

To trace the ancestry of the Society it is necessary to take a glance at the town of Warrington, for here originated much of the spirit that was afterwards transplanted to Manchester and gave the Society its start. In the year 1757 an Academy was founded in Warrington for a small body of religionists, the projector of the institution being the Rev. John Seddon, and was established for "Protestant Dissenters." Several men of eminence took part in its classes, notable amongst whom was Joseph Priestley, who joined the Academy in 1761 as teacher of languages and *belles lettres*. Owing apparently to the pecuniary difficulties into which the Academy was drifting Priestley's connection with the Institution was broken off in 1767 by his removing to Leeds as minister of the congregation at Mill Hill Chapel. Although some effort was made to keep the Academy alive, yet the unbusinesslike habits of its trustees could not keep the establishment from sinking, and it was dissolved in 1783.

When the Academy at Warrington first opened its doors to the ardent youths of the district, the first name that was enrolled on the list was that of Thomas Percival, who ultimately became one of the founders of the Manchester Society. It was here that young Percival was first stimulated to the study of science, under the guidance of such men as Priestley and Dr. Aikin, and acquired that enthusiasm for natural phenomena which he afterwards carried with him to Manchester. After a complete medical education, beginning at Edinburgh, passing to London, and then to Leyden, Dr. Percival took up his residence in Manchester to follow out his profession. Dr. Percival did not, however, allow his professional engagements to engross all his time; with his high social position and scientific tastes he soon attracted all the talent of the town around him, and the outcome of the pleasant social gatherings at his house was the foundation of the Manchester Literary and Philosophical Society, the first formal meeting taking place in 1781. There are many Societies which can trace their origin to such small beginnings as those of which Manchester may boast; indeed those Societies which have existed for any time have as a rule arisen from private social gatherings of men meeting to exchange ideas as a form of relaxation from the weightier matters of daily life.

Evidently the moving spirit at this time with regard to scientific matters in Manchester was Dr. Percival. He had already won some distinction by his early writings on sanitary subjects. His first attempts at sanitary reform date as far back as 1773, about which time he put forth his "Proposals for Establishing more Accurate and Com-

prehensive Bills of Mortality in Manchester," advocating the establishment of a register of births and burials in every town and parish, which he considered "would be attended with the most important advantages, medical, political, and moral."

The important action taken by Dr. Percival and his friends was the establishment of a committee for superintending the health of the poor in Manchester and Salford. From Dr. Percival's remarks in 1796 the contemplated objects of the Board of Health were—

1. To obviate the generation of diseases.
2. To prevent the spreading of them by contagion.
3. To shorten the duration of existing diseases, and to mitigate their evils, by affording the necessary aids and comforts to those who labour under them.

The thoughts that were then spoken, and the plans proposed for lessening the evils that arise as regards sanitary matters when masses of human beings congregate together, the greater part of ~~whose~~ existence consists of a struggle for the bare necessaries of life, were the same as those of the present generation, and yet the evils and consequent misery remain. So much, indeed, were sanitary matters discussed at this period that Manchester became the great centre of sanitary "reform," and Dr. Percival its true apostle.

With respect to this subject it is interesting to learn that as early as 1852 the use of carbolic acid as a disinfectant was well known in Manchester, and the manufacture of such powders carried on by Mr. Alex. McDougall.

It was not till 1785 that the first volume of the Society's *Memoirs* was published, or four years after the first meeting had taken place, namely in 1781. At this first meeting the Presidents were Peter Mainwaring, M.D., and James Massey, Esq. Dr. Percival's relation with the Society at this point seems rather vague, for the author tells us that "he (Dr. Percival) was not in an active condition at the time, and did not attend the first seven meetings, and was not first President," whereas in the list of "present" at the second meeting we notice Dr. Percival's name; also in the first list of members published by the Society, Massey and Percival are Presidents.

In the "Memorials of St. Ann's Church by the Rev. C. W. Bradsley, M.A.," the foundation of the Society is claimed for the Rev. Samuel Hall, a Minister and Curate of St. Ann's. This clergyman by his activity may have helped to make the movement a decisive one, but there seems to be no reason for altering the account of the ruling spirit in the matter.

Some of the extracts from the earlier papers read before the Society, with which Dr. Smith has interspersed his history, appear somewhat amusing to the present generation, being clothed in the then accepted theories in science; and reading them one cannot help wondering in what light our now present hypotheses regarding atoms and molecules, bonds, valence, and constitutional formulæ will appear to the readers of science a hundred years hence. In an address by Thomas Henry, F.R.S., "On the Advantages of Literature and Philosophy in general, &c.," read in 1781, he says—"Bleaching is a chemical operation. The end of it is to abstract the oily and phlogistic parts from the yarn or cloth, whereby it is rendered more fit for acquiring a greater degree of whiteness and absorbing the particles of any colouring materials to which it may be exposed." And again—"The ingenious Dr. Priestley has even taught us the art of fabricating it (common air) artificially, of producing it in a degree of purity far exceeding that of the most salubrious climate, and of reducing it to the state in which we commonly breathe it when debased by exhalations from the various bodies which it surrounds. This excellent philosopher.... has also first discovered....the method by which Nature makes use of the leaves of vegetables to purify the atmosphere, when contaminated with putrid or phlogistic vapours."

One prominent figure in the Society at the beginning of this century was Dr. William Harvey, F.R.S., whose work on the absorption of gases by water has come down to us. Born in 1774, he became assistant to Dr. Percival, went to Edinburgh for his medical degree, in which town he studied chemistry under Dr. Black, his enthusiasm for science being raised to the highest degree. The facility he had acquired in manipulating with gases was considerable, and was turned to good account. By the electric spark he decomposed muriatic acid over mercury and obtained calomel and hydrogen, the result of which experiment, however, was not interpreted by him. By his experiments in 1803 on the absorption of gases by water he supported the theory of Dalton that the effect was due to mechanical agency. He also applied spongy platinum for effecting the combination of hydrogen with oxygen.

In a kind of prelude to a short biographical notice of Charles White, F.R.S., the author of a volume entitled "An Account of the Regular Gradation in Man and in Different Animals and Vegetables, &c., from the former to the latter," one of the original four Vice-Presidents of the Society, Dr. Smith employs some hard phrases with regard to the supporters of those theories bearing upon the variations observed in organised matter that have been most energetically brought forward during the last twenty-five years. The Manchester Society has already two names on its scroll of which it may well be proud, of men who have mightily influenced the study of material phenomena, and we see no reason, therefore, why it should not have had its pre-Darwin. "Few people would expect the doctrine of progress in creation to have any representatives in the early Manchester Society, but this is chiefly because it seems so little known how far the world had advanced in the idea, and how many persons allowed it to pass through their minds."

What is true of this theory is only too true of all others that have played any important part in knowledge,—the great difficulty in assigning the due amount of credit to each individual thinker. No great theory ever sprung into existence at once: there has been a slow progress of development in these things as in the progress of organised matter, and the unconscious influence that previous notions or previous varieties bear upon the present cannot very well be traced.

We are told that "Gradation in animals Dr. White saw clearly, but he refused to believe in development from species to species," but in view of the many writers previous to the time of White, through whose minds the same ideas of "progress" had hovered and passed in a dim and vague form, we experience difficulty in determining what and how much credit is to be given to Dr. White for his views with respect to this doctrine. Dr. Smith states that "there is a kind of insanity spreading among scientific specialists, strongly developed among Darwinians so-called, but the larger mind of Darwin never sanctioned it. They speak of natural selection as a power, when it is only a method by which a power operates. In the same way differentiation is treated as a power, and people actually think they explain when they tell us of this occurrence in nature. This, instead of stength, is the utmost weakness. Darwin has not shown this, but the weaklings (and nearly all his followers have been slow to reason) will now probably think that geotropism and apogeotropism will take the place of nature's most occult laws, and will fancy these words also to be explanations." These are sweeping statements to make, and we can do no more than quote them here. The meanings to be attached to the words "power" and "method" as used in these statements are to us vague: the phenomena mentioned, however, appear to us as the attributes of organised matter, and show its wonderful plasticity in responding to external conditions. We grant that some enthusiasts may have overstepped the bounds of reason, and in consequence we may have a surfeit of "organic progression" as well as of atoms and molecules. A theory that is shown to explain, to the satisfaction of many, various phenomena, may be pushed too far, and produce a reaction. Dr. Smith evidently admires some

of the arguments that have been brought forward with regard to the great law of progression in creation, and states that "some people also think that the 'survival of the fittest' is a great discovery," and asks "what else could survive?" "Were there ever men who believed that the least fit to live could live longest? It is, however, a telling expression—a name for a fact." Is this fact, then, self-evident, and does Dr. Smith see among the races of human beings in their present states of civilisation the "fittest" alone surviving? If so, the term "fittest" requires a clear definition, and he must grant that nature takes as much if not more care in preserving, refining, or developing what we are accustomed to look upon as the morally bad sentiments as those on the other hand which are considered to form the beautiful, the pure, the unselfish side of one's character.

The central figure in Dr. Smith's book is John Dalton, a man, to use the words of Dr. Smith, when he arrived amongst the members of the Society, whose "education was meagre; he could not make Latin quotations with Dr. Percival, or search into early classic writings with Dr. Falconer; his knowledge of Greek was but slight and gained from a little-used 'Schrevelius'; his manners were not formed amongst men who attended the Court; he kept no private carriage, and invited no one to dine with him. He did not even read much poetry, and he thought little in the region of metaphysics, . . . , but the whole force of his mind was directed to the explanation of natural phenomena."

It must have been a memorable day in Dalton's career when he arrived in Manchester in 1793 as Professor in the Academy. He did not come empty-handed, for his "Meteorological Observations and Essays," which he had worked on during the previous five years, he brought with him ready for publication. As a professed mathematician he entered the Society, but his mind soon took its natural bent—the study of phenomena.

Dalton's first publication in the *Society's Memoirs* was entitled, on "Extraordinary Facts relating to Vision of Colours," in which the anomaly now known as "colour-blindness" was described. It would seem, however, that the attention of the Society had already been drawn to this fact before Dalton's time, for Dr. Smith tells us that "the discovery of colour blindness has hitherto been given to Dalton, and unquestionably he first raised it into the region of science; but it has not been observed so far as the writer knows, that Mr. Bew or anyone else had observed the peculiarity."

The great work of Dalton, the "Doctrine of Chemical Atoms," is dealt with at considerable length by Dr. Smith, and the claims that have been made for Wenzel and Richter are discussed, as well as the history of the atomic theory amongst the early Greek philosophers. Much of this account has been taken from a former work by the author, now out of print; nevertheless it is advisable to reproduce it here in support of Dalton's claims.

It would seem, from Dr. Smith's account, that Wenzel's claims as the discoverer of reciprocal decomposition, have been going through the world greatly as a matter of hear-say, as from the difficulty the author experienced in obtaining a copy of Wenzel's work, few persons read it, or accurately knew its contents. Dr. Smith, however, has read the work carefully, and it may be well to give a few quotations of his opinion:—"To Wenzel has often been given the honour of discovering reciprocal proportion, but we must conclude that he failed in his attempts to explain the mutual decomposition of salts, and considers that it is not complete. . . . . I found no such passages as are imputed to him. . . . . It is a curious fact that not only does he not see this [reciprocal saturation], but he sees and explains the contrary, as he shows us that in double decomposition something always remains unsaturated, but generally very little remains."

We are inclined to consider Dr. Smith's opinion in this matter an impartial one, unbiassed by any feeling to attempt to claim more honour for Dalton than is his due; still we cannot but think that Dr. Smith is somewhat rash in his statements regarding some of Wenzel's ideas. To quote again:—"He [Wenzel] seeks to explain affinity by the time of action, and says: 'The affinity of bodies with a common solvent is in the inverse ratio of the time taken to dissolve.' To attempt to give the numerical or dynamical ratio of every body to each other was an object of the very highest kind, and we must look on him as one of those less fortunate men, who, when search was required in every direction, has had the wrong one assigned to him. He searched in the direction of time, and obtained a manifest fallacy; as bodies are constructed abstractedly he might be correct, but his theory cannot be introduced into science at present, and in the way he introduced it it is entirely a mistake."

Now, one thing seems certain, and that is that the method by which chemical affinity is to be measured is not clear; indeed, the very term itself is ambiguous. We know, for instance, that bodies may be cooled to such a temperature that no chemical action is perceptible, no affinity is manifested between them, or they may be heated so highly that the same appears true, whilst at intermediate temperatures action takes place, and probably at some fixed temperature the rate at which this action takes place, the manifestation of the affinities between the bodies, exhibits itself most. Wenzel's axiom may not be quite correct, still the idea of time must be and has been in recent years introduced into investigations on chemical affinity; and the rate at which chemical reactions progress, or the energy with which affinity shows itself, how physical causes and foreign substances influence the rate, will most assuredly form one of the grand keys to the comprehension of the mysterious action we call chemical, which has hitherto been so sadly neglected, and its study may even lead to a more rational classification of chemical compounds on a dynamical basis.

Dalton's theory has now been before the world for three-quarters of a century, and it has certainly not been neglected. By its aid the facts of chemistry have been raised from a chaotic heap to one of order. No matter how amply it explains the numerical relations as regards the masses or weights of chemical compounds, one cannot be blind to the great difficulties in viewing phenomena, as being produced by indefinitely small monads, such monads for instance as we are treated to in the kinetic theory of gases, flying through space, whirling and dancing to the eternal clatter of their own encounters. To conceive, for instance, a mixture of two such monads as hydrogen and oxygen, and observe the effect of heat upon them or the passage of an electric spark, it is difficult to comprehend how the "union" can take place. Their agitation must be great before they join hands, by their ceaseless collisions; but we must agitate them a little more, and see the result, or agitate them still more strongly, and again see the new result in their splitting asunder. So, again, in such a case as the passing of chlorine over phosphorus: three monads or five monads of the chlorine attach themselves to one of the phosphorus; but what about the intermediate stages from the one to the five which must take place in course? We may assume hooks, or claws, or bonds, nuclei with ether spheres, vortices, and what not, repulsions, or attractions as the inverse fifth or other power of the distance to bring theory and fact into harmony; but these assumptions seem to us only to indicate the great difficulty universally felt of co-ordinating the theory of monads with the phenomena of matter. A deep study of what we call chemical action is required, not constitutional formulæ or equations, to form a new theory of the constitution of matter.

That period of the Society's growth which is considered as the intermediate would seem to be essentially an engineering one, and is marked by some well-known names. A notable figure during this period is that of Sir William Fairbairn, Bart., F.R.S., whose mechanical ability has earned for him a high position in the annals of engineering. His career might be well worth a close

study, as his success lay not in an elaborate scientific education or an expertness with the symbols of the mathematician, but resulted more from instinctive feeling of what ought to be.

Another eminent engineer who adorned the Manchester Society was Mr. Eaton Hodgkinson, F.R.S., by whose assistance, with a high scientific training and knowledge of the strength of materials, no small part of Fairbairn's engineering works were rendered successful, including the stupendous undertaking over the Menai Strait.

A most remarkable man, a member of the Society, was the electrician, William Sturgeon, whose discoveries and inventions in electricity may be traced under modified forms in many of the principal electrical apparatus now in use, but whose claims to honour are well nigh if not quite ignored. He was born in 1783, and from first to last his life was one of labour and poverty, yet it is marvellous how much excellent work he performed in the trying circumstances. Beginning life as a private soldier, in spite of all the difficulties inherent in such an existence, by great industry he acquired considerable proficiency in science, not neglecting either the literary side of education. His contributions to science, commencing in 1823, are about fifty in all, published in the *Philosophical Magazine* and the "Annals of Electricity," all bearing on his favourite study, electrical phenomena. To Sturgeon we are indebted for the soft iron electro-magnet, the commutator, and the amalgamation of the zinc plates of batteries and numerous electrical investigations, but we must refer to Dr. Smith's book for a full account of his work. Sturgeon's claims have been sifted to the utmost, and firmly established by Dr. Joule, whose account of the life of this remarkable man is to be found in the *Society's Memoirs*, vol. xiv., 2nd Series.

One of the last scientific notables in Dr. Smith's volume is Dr. Joule, but, as he is still alive, only a few pages are given to him. His great work, however, on the mechanical equivalent of heat, and his speculations and calculations on the motions of atoms of gases, are so well known that it is needless to recapitulate them here. Only a few scanty extracts are given of Joule's writings, as is also the case with Dalton. To the exclusion of less important matters had the writings of these two representatives of science been more liberally inserted, we think the volume would have gained in interest.

In a concluding chapter Dr. Smith gives a short and explicit account of the present state of the Manchester Society, and of the obstacles that are gradually rising with regard to want of new buildings and money matters, which prevent it taking its proper position and accomplishing the amount of good that is to be expected of a scientific centre in a district swarming with life and activity.

Dr. Smith's work is, as we have already remarked, of essentially local interest, but nevertheless forms a valuable contribution to the historical literature of science, and may be looked upon as a work of reference to the more important memoirs read at the Manchester Society, since its commencement one hundred years ago. We wish the Society every success in the reforms that are contemplated, and that it may survive for another and many more centuries in the struggle for existence amidst the numerous scientific societies and institutions that are now arising.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Bulletin de la Société Chimique de Paris.
Vol. xli., No. 1, January 5, 1884.

Remarks on Thermo-chemical Data.—M. Berthelot.—The author comments on the agreements and disagreements existing between his results and those of M. Thomsen, and complains that the latter shows a disposition to make the most of the occasional discrepancies and to charge him with inaccuracy.

Researches on Nitrogen Iodide.—Antony Guyard.—This memoir has already appeared at greater length in the *Moniteur Scientifique* of November last.

Researches on the Double Copper and Nitrogen Iodide.—A. Guyard.—This paper also is an abridgment of one which has appeared in the *Moniteur Scientifique* for November last.

Action of Iodine upon Potassium Seleno-cyanide.—A. Verneuil.—The result of the reaction is a compound $C_6N_3KSe_8$, which is obtained in brilliant red crystals, of a disagreeable odour. They are decomposed at once by water, but more gradually by moist air, yielding potassium seleno-cyanide and selenium. They are also destroyed by a temperature of 120°, leaving the same products, whilst cyanogen is given off. If this compound is treated with absolute alcohol selenium is deposited, and there remains in solution a new compound of the composition $C_6N_3KSe_6$, corresponding to a persulphocyanogen, in which the hydrogen is replaced by potassium.

The "Emetics" of Mucic and of Saccharic Acid.—D. Klein.—The term emetic is here used not in its medical sense but as the generic name of a class of bodies of which tartar emetic, —the double antimony and potassium tartrate—is the type. It does not appear whether either of these compounds can be used in dyeing and tissue-printing in place of the double tartrate.

Determination of the Tannin in Vegetable Substances, especially in the Barks of the Oak, Birch, Fir, Quebracho, Cinchona, in Dividivi, and in Galls, &c.—M. Perret.—Inserted in full.

Cosmos les Mondes,
No. 15, December 8, 1883.

Process for obtaining a very Fine Iridescent Metallic Colour.—Dissolve 64 grms. of common salt in 130 grms. of water, and add 30 grms. nitric acid. The mixture is then poured hot upon a sheet of tinned iron laid upon a stoneware vessel. When the process has been repeated several times the plate is washed in acidulated water. [Where is the novelty?]

Measurement of Electromotive Forces.—M. E. Regnier.—This memoir requires the accompanying illustrations.

Nos. 17, 18, Dec. 22 and 29, 1883, and No. 1, Jan. 5, 1884

These issues contain no chemical matter.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin,
Vol. 16, No. 7.

Silver Nitrate and Ammonia.—A. Reychler.—In addition to the two compounds of silver nitrate and ammonia already known, the author describes a third, O_2NONH_3Ag. He examines also the brown precipitate obtained by adding ammonia to a neutral or faintly acid solution of silver nitrate, and gives a preliminary notice of a compound obtained on submitting a concentrated solution of silver-ammonium nitrate to dialysis, and a precipitate, argentamin-aldehydate (?), formed on adding an aqueous solution of silver-ammonium-nitrate to aldehyd.

Iso-benzil.—H. Klinger.—Iso-benzil crystallises from alcohol in shining leaflets and needles, and from ether in compact crystals, which melt at 155° to 156°. Its solution in carbon disulphide is decomposed by bromine with the formation of ordinary benzil and benzoyl-bromide.

Basic Double Salts.—H. Klinger.—The author's attempts at obtaining basic lead-cadmium nitrates were not successful. He produced double basic salts of mer-

cury and lead with lime by adding mercury and lead oxides to boiling solutions of calcium chloride or nitrate.

A New Reaction of the Tellurium Compounds.—E. Divers and M. Shimosé.—Already inserted.

History of the Sulphonic Acids of Para-cymol.—A. Claus.—Reference to a recent controversy.

Oxidation of Penta-chlor-naphthaline.—A. Claus and H. v. d. Lippe.—The authors find that the trichlor-naphthoquinon of Claus and Spruck is not genetically connected either with tetra-chlor-phthalic acid or with penta-chlor-naphthaline, but is formed merely as a by-product of α-dichlor-naphthaquinon. They describe also tetra-chlor-naphthoquinon.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Centrifugal Machine.—Would any of your readers kindly inform me if centrifugal machines are made of glass? and, if so, what are the makers' names?—Centrifugal.

MEETINGS FOR THE WEEK

Monday, Feb. 18th.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "Building of London Houses," by Robert W. Edis, F.S.A.

Tuesday, 19th.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.

Wednesday, 20th.—Society of Arts, 8. "Reclamation of Land on the North-Western Coast of England," by Hyde Clarke.
— Meteorological, 7.
— Geological, 8.

Thursday, 21st.—Royal, 4.30.
— Royal Society Club, 6.30.
— Chemical, 8. Ballot for the election of Fellows. "An Analysis of Spottley Bridge Spa Water," by H. Peile.
— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
— London Institution, 7.

Friday, 22nd.—Royal Institution, 8. "London (below bridge) N. and S. Communication," by Sir F. Bramwell, at 9.
— Quekett Microscopical Club, 8.

Saturday, 23rd.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.
— Physical, 3. "On the Adjustment of Resistance Coils; and on a Modified Resistance Balance," by S. P. Thompson, D.Sc. "On the Difference of Potentials required to give Sparks in Air," by Prof. G. Carey Foster, F.R.S.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1265.

ZINC IN DRINKING-WATER.

By C. W. HEATON.

THE water supplied to Cwmfelin, near Llanelly, is drawn from a spring at Penderry, and carried for about half a mile through a galvanised iron pipe. Mr. J. Raglan Thomas, the Medical Officer of Health for the district, detected zinc in the water of this pipe, and sent me samples from the spring and from the pipe for further examination. I obtained the following results:—

	Grains per Gallon.	
	Spring.	Pipe.
Total solids..	10·8	18·9
Chlorine	1·47	1·45
Ammonia	none	0·008
Nitrogen as nitrate	0·056	none
Zinc carbonate in solution in carbonic acid	none	6·41

The solvent action upon zinc of water containing dissolved oxygen and free carbonic acid is, as the above figures show, considerable. As far as I know it has not been observed before.

I confirmed the analysis by a simple experiment. Distilled water containing some fragments of pure zinc was exposed for about half an hour to a stream of oxygen and carbonic anhydride. The filtered liquid was found to contain much zinc in solution, this zinc being readily precipitated as carbonate on boiling.

It will be seen that the Penderry water is very pure. The reduction of the nitrate to ammonia by the action of the zinc is a noteworthy feature in the case.

Charing Cross Hospital,
February 15, 1884.

ON A

WEIGHT VOLTAMETER FOR MEASURING ELECTRIC CURRENTS.

By LAURENCE N. LEDINGHAM.

WHILE experimenting on apparatus for measuring electric currents, the idea of doing so by means of a weight voltameter suggested itself as being a method which, at all events, would have the advantage of being constant and unaffected by external agents, as temperature, pressure, magnetism, &c. The following is a brief description of one of the forms which I constructed and experimented with.

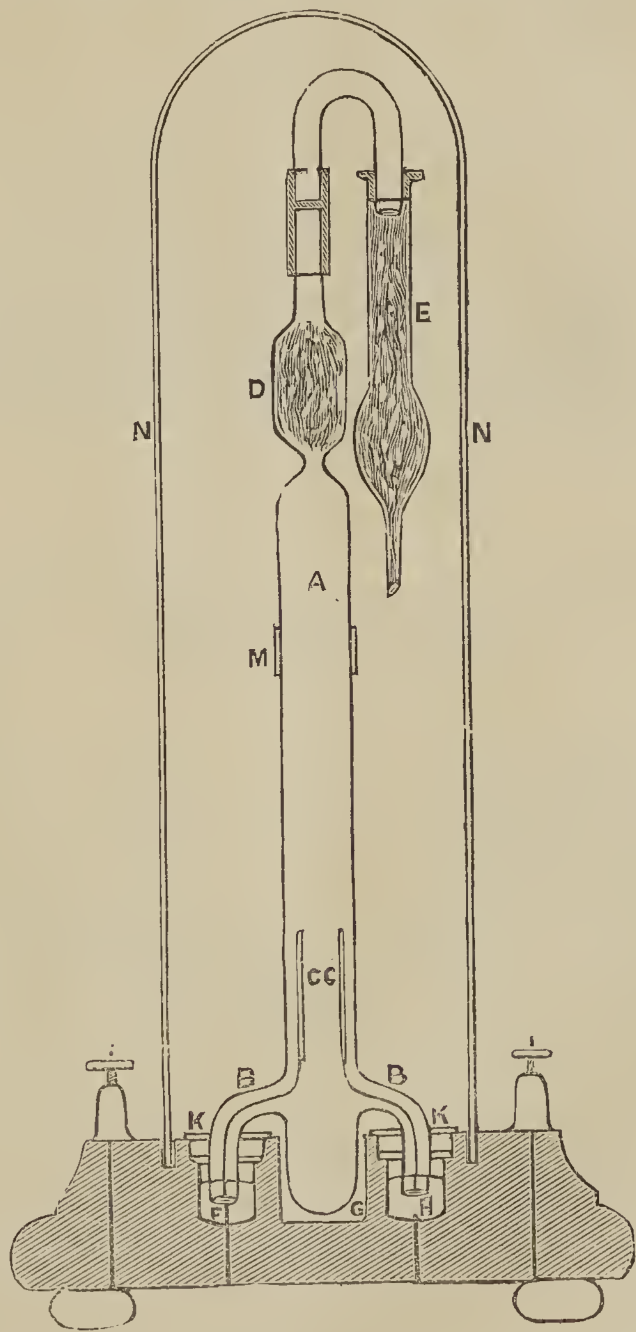
Description.

It consists, as will be seen from the drawing, of a glass tube, A, provided with two arms, B B, containing the platinum wires, which are welded to and support the electrodes, C C; the bulb, D, is filled conveniently with pieces of thin glass tube; these serve to keep sparks of water from being mechanically carried over into the drying tube, E, containing chloride of calcium.

The stand has three circular cavities, F, G, and H. G holds the bottom of the voltameter, and F H accommodate its arms, B B. F and H contain mercury, and are connected with copper wires to the binding screws, I I; they are fitted on the top with round pieces of sheet rubber, which are fastened to and kept in their places by means of small portable wooden rings, K K. These rubbers being slit nearly across form valves, which permit of the apparatus being shifted about without loss of mercury, at the same time freely admitting the arms, B B. These mercury pools form a cool and reliable connection, and to a great extent do away with the inconveniences and risks tending the direct connecting of the terminals with the platinum wires, as notably the heating of the junctions and the cracking of that part of the glass into which the wires supporting the electrodes are fused. N N represents a 9-inch glass shade.

Taking a Measurement.

The terminals of the wires, through which the current to be measured flows, are fixed in the binding screws, I I, and the voltameter freed from air by allowing the elec-



trolysis to proceed for a minute or so; it is now suspended from a balance by a wire, then placed in the spring clip, M; at a noted time the circuit is completed by pressing the arms, B B, into the mercury pools, F and H. The electrolysis is continued for some minutes, when, at a noted second, the current is broken by raising B B out of the mercury. The voltameter is again weighed; the difference gives the *exact amount of water electrolysed.*

Now, by referring to the known fact that, "the amount of water electrolysed in a given time is exactly in proportion to the current strength, and a unit current decomposes 0·0000945 of a grm. water in one second," the current strength, then, in Ampères is got by dividing the

weight of water electrolysed by the constant 0·0000945, multiplied by the time taken reduced to seconds.

Thus, $C \times t \times 0{\cdot}0000945 =$ Wt. water decomposed.

$$\therefore\ C = \frac{\text{Weight water decomposed.}}{0{\cdot}0000945 \times t.}$$

Let W_1 = Original weight of voltameter.
W_2 = Weight after passage of current.
T = Time in seconds.
C = Current in Ampères.

Then, $W_1 - W_2$ = Wt. of water electrolysed.

$$C = \frac{W_1 - W_2}{0{\cdot}0000945 \times T}$$

Example—

$W_1 = 52{\cdot}3215$ grms.
$W_2 = 52{\cdot}2199$,,
T = 600 seconds.

$$\therefore\ C = \frac{52{\cdot}3215 - 52{\cdot}2199}{0{\cdot}0000945 \times 600} = 1{\cdot}791 \text{ Ampères.}$$

Note.—This form of voltameter is not adapted for the measurement of very strong currents, but rather for laboratory and experimental work, where accuracy and constancy are of first importance. When the liquid (acidulated with sulphuric acid) requires renewing, the apparatus is held by A in the warm hand, by which means some of the gases or air will be expelled. If, now, a little water (free from acid) be dropped into D, it will, on removal of the hand, be sucked into A.

Govan, Feb. 16, 1884.

COAL-GAS AS A LABOUR-SAVING AGENT IN MECHANICAL TRADES.*

By THOMAS FLETCHER, F.C.S.

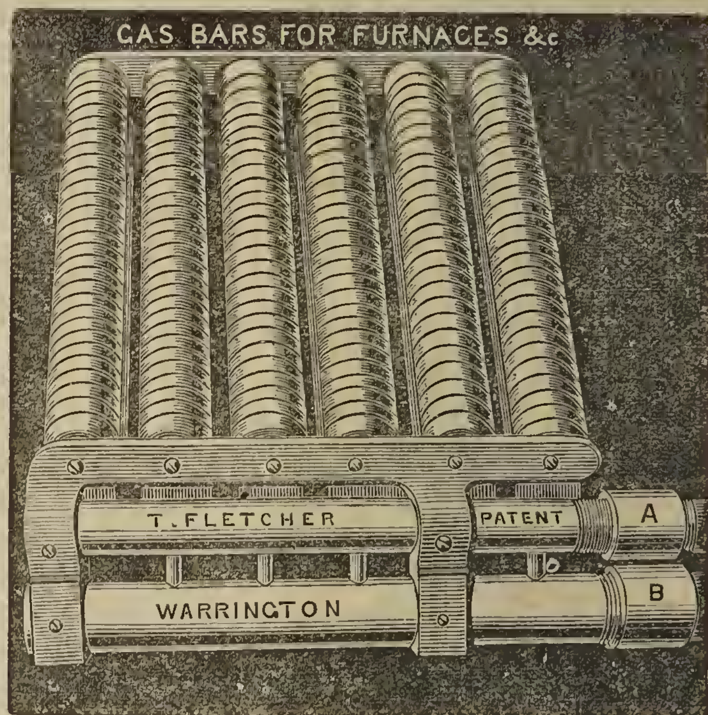
(Concluded from p. 76).

In such processes as the roasting of coffee, chicory, grain, &c., a diffused heat is necessary, but of much greater intensity than can be obtained with economy from heated air. In these cases the application of a direct flame is necessary, and it may be in actual contact with the substances to be heated, provided these are kept in constant and rapid motion.

The use of a revolving cylinder brings in complications with any burner which is supplied with gas at ordinary pressures without any artificial air supply, as the currents of air caused by the motion of the cylinder interfere with the satisfactory working of any burner, and the air supply must be either protected from draughts and irregular air currents, or the air must be supplied artificially from some independent source. One exceedingly good way of making any burner work, independently of the currents caused by a revolving cylinder, is to apply the flame inside the cylinder at the centre, making the substances to be heated to fall in a continuous stream through the flame. This system is not applicable to fine powders, or sticky substances, as it necessitates the perforation of the cylinder, to allow of the escape of products of combustion.

For this class of work, a very concentrated heat is not desirable, as a rule, and a slit, or perforated burner is preferable. Of this class of burner I have here a sample, which is not only new in its constructive details, but has great and special advantages for many purposes. Fig. 2 resembles a number of ordinary furnace bars, with this difference, that each bar is a burner; in fact, it is an ordinary furnace grate, which supplies its own fuel. With the usual day pressure of gas, = 1 inch of water, this burner will, at its maximum power, consume about 100 cubic feet of gas per hour, per square foot of burner surface, and as it can readily be made almost any form or size, its adaptability for a great number of uses is evident. I have made it in many sizes and shapes, to give flames from ½ inch wide by 5 feet long to large square or oblong blocks. By applying a blast of air at the ordinary gas jets, and supplying the gas by a separate pipe, or series of pipes, below the open end of the burner, this can be converted into a furnace of extraordinary power. It is quite possible to burn as much as 2000 cubic feet of gas per hour, per square foot of burner surface, producing a heat sufficient to fuse any ordinary crucible. You see its power when I place a bundle of iron wire in the flame; it is, in fact, a concentration of hundreds or thousands of powerful blowpipe flames in one mass. It has also this advantage, that with a blast of air it will burn and work equally well any side up, and the flames can therefore be directed straight on their work without loss. It is, in one form or another, almost a universal burner, as it can be readily adapted to almost any purpose, from tempering a row of needles to making steam for a 200 horse-power steam-engine. It is easy to make, easy to manage, practically indestructible, and for commercial purposes has, I think, a general adaptability which will bring it, in one form or another, into almost universal use. I may say that when we are in a special fix, this has in every case landed us out of the difficulty.

Fig. 2.



For heating large plates of metal equally, for drying paper impressions for stereotypers, hot-pressing hosiery, crumpet baking, working up plastic masses which can only be worked hot, and work of this class, a number of separate flames equally diffused under the whole surface of the plate are necessary to equalise the heat, unless the plate is very thick, and these are better if produced by a mixture of gas and air, but in heating wide plates one difficulty must always be remembered, the burnt gases from the centre flames can only escape by passing over the outer flames, and therefore a space must be left between the top of the flame and the plate, or the outer flames will be smothered and make a most offensive smell.

In hosiery presses, printers' arming presses, and many others, the top plate also requires to be heated. The best way to do this is to use a number of blowpipe flames directed downwards. In many cases the supply of air under pressure is a practical difficulty and objection. This is overcome, to a certain extent, by the use of a thick upper plate with a number of horizontal holes, into which a Bunsen flame is directed. In every case I have seen,

* A paper read before the Society of Arts, January 30, 1884.

without one single exception, the holes are either too small, or the burner is placed too close, and the consequence is that the gas, instead of burning inside the holes, as it should, passes through partially unburnt, and is consumed at the opposite end, where it is absolutely useless, the flame not being in contact with or under the surface to be heated, and therefore doing no work. In hosiery presses this is a great objection, as the holes are so long that an equal heat is simply impossible, and the only remedy is to use a blowpipe flame, which forces sufficient air in with the gas to ensure combustion where the heat is necessary. The same remark applies to crape and embossing rollers.

For the production of heat in confined spaces and difficult position the use of an artificial blast of air is becoming an acknowledged necessity, and the small Roots blowers now made for such purposes, and driven by power, are coming rapidly into use.

Sometimes a plate is required to be heated to a high temperature in one confined spot, and, as an example of this, I may take the blueing of the hands of watches. For this purpose I have made several arrangements, and perhaps the best is a thin copper plate, bent down at one side to a right angle. In this angle, underneath is directed a very fine blowpipe flame on one spot, and the hands are passed singly over this spot until the colour comes, when they are instantly pushed over the edge. I have here the arrangement which is generally used for this purpose. For the blueing of clock hands, a larger and more equally heated surface is required, and this can be obtained by a small powerful burner without a blast of air, using a rather thicker plate to equalise the heat (Fig. 3). The same arrangement may be used with advantage for tempering small cutters for ornamental turning, penknife blades, &c., and in these cases the cooler part of the plate is of great value, as it enables the thicker parts to be slowly and equally heated up; the application of a mechanical arrangement to pass the articles to be heated in a regular succession is a matter easily managed.

Among other things which have several times come under my notice, may be mentioned cremation furnaces, but I have not yet met with, or been able to devise, any burner for ordinary coal-gas which has worked satisfactorily. This fuel is apparently unfitted for the work, and the best arrangement I know is a number of pipes delivering ordinary "producer" gas from the Wilson or Dowson generators, in exactly the same way as is at present used for firing horizontal steam boilers. For heating bookfishers' tools, a ring-flame is the simplest, the tools being supported a little distance above the flame; the usual plan of heating a plate, and placing the ends of the tools on this, necessitates at least double the gas consumption as compared with an open flame For type-founding machines, bullet moulding, stereotype metal melting, solder making, lead melting, &c., one burner, or rather one flame, should be used of a suitable power for the work, and this should be as perfect and of as high a temperature as possible to ensure economy. It is now a simple matter, owing to recent researches in the theory of heating burners, to obtain flames of any power without practical limit, which, without any artificial air supply, will do all which is necessary in this class of work, and the required arrangements are exceedingly simple. With these trades may be classed, also, the concentration and distillation of acids and liquids boiling at a high temperature, and we may also include baths for tinning small articles, and the tinning by fusion of sheet copper, the same burners being applicable, and perfectly suited to all these requirements, unless the tinning baths are long and narrow, in which case the furnace-bar burners again come to the front as the best; as, if we are to use gas economically, the flame must be the same shape as the vessel to be treated.

Fig. 3.

Fig. 4.

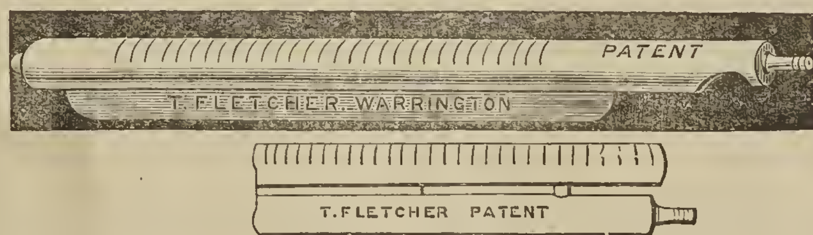
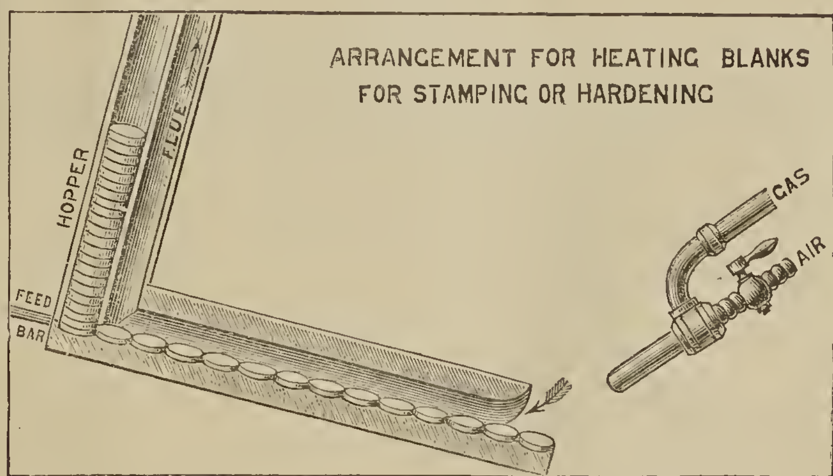


Fig. 5.



We may now consider the heating of blanks for stamping, hardening the points of spindles, finishing the ends of umbrella tips, and work where a small article, or a small part of any article, has to be heated to a high temperature with speed and certainty. For these a long and narrow flame is necessary, and I may mention that in cases where a high speed of delivery is required, and a small part only has to be heated, such as, for instance, in the hardening of the points of spindles for cotton machinery, I have made burners giving a flame of exceedingly high temperature only $\frac{1}{4}$-inch wide and 5 ft. long. This flame is produced by the assistance of a blast of air, and is of a sufficiently high temperature to fuse the spindle in a few minutes. (Fig. 4).

The points only project over the flame, and the spindles are carried mechanically at such a speed that at the end

of the 5 ft. traverse they are red-hot, and drop into water. More than one hundred are in the flame at once, lying side by side.

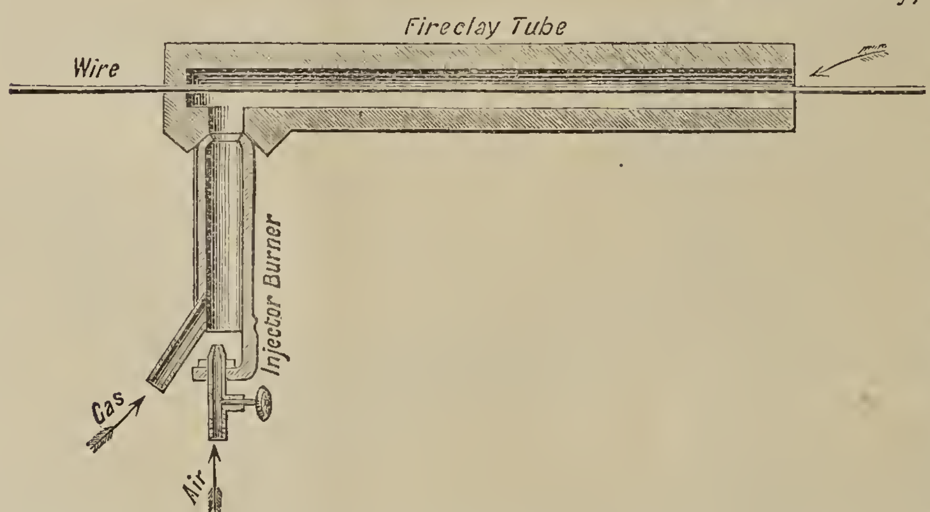
For heating blanks for stamping, the furnace bar-burner is perfectly suited, and in this work the shoot supplying the blanks to the machine should be made of two fireclay sides, with an opening for the flame between the shoot and flame being placed at a sharp angle, to prevent risks of the blanks sticking or over-riding each other. A blowpipe may also be used with good effect, as shown in Fig. 5, and in many cases it is preferable and much easier to manage.

In some cases, the direct contact of the flame would spoil the articles to be heated, and instead of the arrangement mentioned, a tube of iron, fire-clay, or other suitable material is heated, and the articles are passed through it. This system of continuous feed, through a tube, has been applied to the firing of small articles of pottery, and might possibly be well adapted, amongst other things, to the production of gas-burners.

Where the contact of air with the heated article is injurious, many plans have been tried to keep the ends closed as much as possible, but I believe no more perfect and simple seal against the admission of air can be devised than to turn a jet of pure gas, unmixed with air, into each end of the tube. This is an absolute seal against the entry of oxygen in an uncombined state; free oxygen cannot exist at a very high temperature in the presence of coal-gas.

For many trades there is a demand for hardened and tempered steel wire, either round or flattened, and the production of this has led to many attempts to obtain a satisfactory continuous process. The common method now, which is worked as a "secret" process by most firms, is to pass the wire through a tube to heat it, as already described, and to run it direct from the tube through a hole in the side of a box filled with oil, the hole being packed with asbestos, to prevent leakage; from this it is passed through another similar hole on the opposite side, either over a plate heated to the right temperature, or over a narrow open flame of sufficient length and power to give the correct heat for tempering.

Fig. 6.



Where absolute precision is necessary, the gas supply must be adapted by an automatic regulator on the main, to prevent the slightest variation of heat. Once adjusted the production of flat and round spring wire by the mile is an exceedingly simple matter. It is quite possible to obtain absolute precision in temperature by a proper adjustment of the gas pressure, and as this is, for tempering steel articles and some other purposes, a matter of great importance, it is worth some consideration. No pressure regulator alone will give an absolutely steady supply; but if we put on first a regulator, adjusted to the minimum pressure of supply, say 1 inch of water; and then fix another on the same pipe, adjusted to a slightly lower pressure, say 9-10ths of an inch, the first regulator does the rough adjustment, and the second one will then give an absolutely steady supply, providing always that the regulators are both capable of passing more gas than is likely to be ever required. No regulator can be relied on for absolute precision, if worked up to its maximum possible capacity.

Amongst other applications of a long narrow flame of high power, may be mentioned the brazing of long lengths of tube, in fact the application of flames of this form, with and without a blast of air, for different temperatures, are almost endless.

The thousands of uses to which blowpipes are adapted are so well known that they need no mention, except the curiously ignored fact that the power of any blowpipe depends on the air pressure. A compact flame of high temperature cannot be obtained except with a heavy air pressure, and the ignorance of this fact has caused an immense number of unexplained failures. Many people think that one blower is as good as another, and expect that a fan giving a pressure equal to, say, the height of a 2 inch column of water, should do the same work as a blower giving a pressure ten to twenty times as great. The construction and power of blowpipes, with the laws ruling the proportions and power, will be found in an article on "Blowpipe Construction," published in *Design and Work*, March, 1881, and as the matter is there fully treated, no further reference to the subject is necessary.

In the more recent forms of gas-engine, the charge is exploded by a wrought-iron tube, heated to redness by the external application of a gas flame. This, although considered satisfactory by the makers, appears to me to be an exceedingly crude way of getting over the difficulty; and I offer it as a suggestion, that a very small platinum tube shall be used instead of iron. This, if made with a porous or spongy internal coating, would fire the charge with certainty, at a lower temperature than iron, and it could be made so thin and small in diameter, without risk of deterioration or loss of strength, that an exceedingly small flame could be used to heat it up. As it would be fully heated in a very few seconds, the delay in starting would be obviated. (Fig. 6.)

There are many purposes for which a red heat is needed for slow continuous processes on a small scale, such as case-hardening small steel goods, annealing, heating light steel articles for hardening, and a great variety of other similar processes. This, until recently, has required the use either of a rather complicated furnace or a blast of air under pressure, to increase the rapidity of combustion. Since the conclusion of my experiments on the theoretical construction of burners, I have found that the high-power burners, previously described, are capable of heating a crucible equal in size to their own diameter to bright redness without the assistance of a chimney, provided the crucible is protected from draughts by a fireclay cylinder.

This is an important point, as it renders the production of a continuous bright red heat a matter of the greatest ease, even in crucibles of a comparatively large size. Where the heat is steady, and certain not to rise above a definite point, it can safely be used for such purposes as hardening penknife blades, and other articles which are very irregular in thickness, the thin edges not being liable to be burnt or damaged by over-heating.

For the highest temperatures air under pressure is a necessity, as we require a large quantity of gas burnt in as small a space as possible with the maximum speed, and, given this air supply, we are very little hampered by conditions, as an explosive mixture may be blown through a gauze into a fireclay chamber, closed, except so far as is necessary to allow the escape of burnt gases. The speed of combustion is limited only by the speed of supply

of air and gas, and by increasing these there is no practical limit to the heat which can be obtained. When we have to do with the reduction of samples of refractory ores, testing the comparative fusibility of different samples of firebricks, or alloys, &c., the use of an explosive mixture blown into and burning in a close chamber is invaluable, and the ease and certainty with which any temperature may be obtained has led to great discoveries and the revolutionising of many commercial processes. Recent experiments have proved that, by a modification in the form of the well known injector furnace, an enormous increase of temperature may be obtained. I have, in actual work, obtained the fusing-point of cast-iron in two minutes, starting all cold, and have fused every furnace casing I have yet been able to produce. If infusible casings can be made, I think I am not overstating facts in saying that any temperature required can and will eventually be obtained with the greatest ease. What the limit is I have as yet not been able to discover.

There is one more application of gas, as a fuel, which, discovered and published by myself some two years ago, has yet to become generally known, and in some special processes may prove exceedingly valuable. This is the addition of a very small quantity of coal-gas, or light petroleum vapours, to the air supplied by a blower or chimney pull, to furnaces burning coke or charcoal. The instant and great rise in temperature of the furnace, and the greater stability of the solid fuel used, are extraordinary. This is, in fact, a practical application of the well-known "flameless combustion," the only signs that the gas is being burnt being a great rise in temperature and a decreased consumption of the solid fuel; in fact, if the gas is in correct proportion, the solid fuel remains unburnt, or nearly so, in spite of the high temperature. In cases where a sudden rise of temperature is required in a furnace, or where the power is deficient, this method of supplementing and increasing the heat will be found of very great service, and processes liable to be checked by making up a fire with fresh fuel can be carried on without check, even after the solid fuel has almost entirely disappeared.

That a solid fuel is quite unnecessary I will prove in a very simple manner, by burning a mixture of coal-gas and air without a flame in a bundle of iron wire. The heat is sufficient to fuse the wrought-iron with ease, and the glare inside the bundle of wire is painful to the eyes. The same result could be obtained by a pile of red-hot lumps of firebrick, and the same heat obtained also without a trace of flame.

It is not possible to enter fully into such a wide and important subject in a single lecture, and the suggestions now given are simply hints for the guidance of those who need or desire to experiment. No doubt we shall have, after a time, some text-books and other literature on this subject, which is one of great importance to many industries; and it is necessary for experimental work and applications to new industries that the experimenter shall not only be able to purchase special burners, but that he shall have fundamental laws laid down which will enable him to construct them for himself, so as to have his experiments under his own control. The difficulty in the way of literature on the subject is that those few who have worked in the matter are busy men, with little time which is not already fully employed.

Pioneers on new ground have a great liability to generalise and jump at conclusions, and the necessary exact work and detail must, to a great extent, be left to those who follow on tracks already roughly marked out.

Of the special trades which have come under my observation I have only had time to mention a very few. It appears to me that there are very few manufacturing processes of any kind, which could not be simplified by the use of gas as a fuel, from the production of electric light apparatus to the manufacture of explosives, cotton stockings, beer, catgut, glue, umbrellas, ink, fish-hooks, medals, stained glass windows, brushes, and other trades equally various, which come daily under my own notice.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

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MOLYBDENUM.

If we leave out of account the inaccurate determination made by Berzelius,† we shall find that the data for the atomic weight of molybdenum lead to two independent estimates of its value; one near 92, and the other near 96. The earlier results found by Berlin and by Svanberg and Struve lead to the lower number; the more recent work of Debray, Dumas, and Lothar Meyer sustains the higher. The latter value is the more probable, although both may be vitiated by constant errors in opposite directions.

The earliest investigation which we need especially to consider is that of Svanberg and Struve.‡ These chemists tried a variety of different methods, but finally based their conclusions upon the two following:—first, molybdenum trioxide was fused with potassium carbonate, and the carbon dioxide which was expelled was estimated; secondly, molybdenum disulphide was converted into the trioxide by roasting, and the ratio between the weights of the two substances was determined.

By the first method it was found that 100 parts of MoO_3 will expel the following quantities of CO_2:—

31·4954
31·3749
31·4705

Mean $31·4469 \pm 0·0248$

The carbon dioxide was determined simply from the loss of weight when the weighed quantities of trioxide and carbonate were fused together. It is plain that if, under these circumstances, a little of the trioxide should be volatilised, the total loss of weight would be slightly increased. A constant error of this kind would tend to bring out the atomic weight of molybdenum too low.

By the second method, the conversion by roasting of MoS_2 into MoO_3, Svanberg and Struve obtained these results. Two samples of artificial disulphide were taken, A and B, and yielded for each 100 parts the following of trioxide:—

89·7919	A.
89·7291	A.
89·6436	B.
89·7082	B.
89·7660	B.
89·7640	B.
89·8635	B.

Mean $89·7523 \pm 0·0176$

Three other experiments in series B gave divergent results, and, although published, are rejected by the authors themselves. Hence it is not necessary to cite them in this discussion. We again encounter in these figures the same source of constant error which apparently vitiates the preceding series, namely, the possible volatilisation of the trioxide. Here, also, such an error would tend to reduce the atomic weight of molybdenum.

Upon discussing the data given in the foregoing paragraphs we get somewhat noticeable results. From the carbon dioxide series, $Mo = 91·711 \pm 0·113$, a figure having no unusual interest. From the other series, if $S = 31·987$ and $O = 15·9633$, we get $Mo = 92·979 \pm 0·354$; but if we take $S = 32$ and $O = 16$, then Mo becomes $= 92·133$. In this case the higher values for oxygen and sulphur lead to a lower number for molybdenum. In the car-

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1. 1826.
‡ *Journ. f. Prakt. Chem.*, 44, 301. 1848.

bonate series the assumption of 12 and 16 for C and O, respectively, makes $Mo = 92·033$. In other words, if we assume the ordinary even numbers for C, O, and S, Svanberg and Struve's two methods yield more nearly concordant results than when the revised values for these elements are taken.

Berlin,* a little later than Svanberg and Struve, determined the atomic weight of molybdenum by igniting a molybdate of ammonium and weighing the residual MoO_3. Here, again, a loss of the matter by volatilisation may (and probably does) lead to too low a result. The salt used was $(NH_4)_4Mo_5O_{17}.3H_2O$, and in it these percentages of MoO_3 were found:—

81·598
81·612
81·558
81·555
Mean 81·581 $\pm$ 0·0095

Hence $Mo = 91·9817 \pm 0·0776$; a result agreeing quite well with those of Svanberg and Struve.

Until 1859 the value 92 was generally accepted on the basis of the foregoing researches, but in this year Dumas† published some figures tending to sustain a higher number. He prepared molybdenum trioxide by roasting the disulphide, and then reduced it to metal by ignition in hydrogen. At the beginning the hydrogen was allowed to act at a comparatively low temperature, in order to avoid volatilisation of trioxide; but at the end of the operation the heat was raised sufficiently to insure a complete reduction. From the weighings I calculate the percentages of metal in MoO_3:—

0·448 grm. MoO_3	gave	0·299 grm. Mo.		66·741	per cent.
0·484	,,	0·323	,,	66·736	,,
0·484	,,	0·322	,,	66·529	,,
0·498	,,	0·332	,,	66·667	,,
0·559	,,	0·373	,,	66·726	,,
0·388	,,	0·258	,,	66·495	,,
				Mean 66·649 $\pm$ 0·030	

In 1868 the same method was employed by Debray.‡ His trioxide was purified by sublimation in a platinum tube. His percentages are as follows:—

5·514 grms. MoO_3	gave	3·667 grms. Mo.		66·503	per cent.
7·910	,,	5·265	,,	66·561	,,
9·031	,,	6·015	,,	66·604	,,
				Mean 66·556 $\pm$ 0·020	

This mean, combined with that of Dumas's, gives a general mean of $66·585 \pm 0·017$.

Hence $Mo = 95·429 \pm 0·057$.

Debray also made two experiments upon the precipitation of molybdenum trioxide in ammoniacal solution by nitrate of silver. In his results, as published, there is curious discrepancy, which, I have no doubt, is due to typographical error. These results I am, therefore, compelled to leave out of consideration. They could not, however, exert a very profound influence upon the final discussion.

The most recent investigation upon the atomic weight of molybdenum is the discussion by Lothar Meyer|| of the experimental results obtained by Liechti and Kemp§ in their analyses of the chlorides. Of these compounds there are four:—$MoCl_2$, $MoCl_3$, $MoCl_4$, and $MoCl_5$. The chlorine in each was estimated as silver chloride, and the molybdenum as disulphide. From these analyses Meyer deduces three sets of ratios, namely:—between $MoCl_n$ and $nAgCl$; between $MoCl_n$ and MoS_2, and between MoS_2 and $nAgCl$. We will use only the first and last of these; the probable error of the atomic weight deduced from the second being relatively so high as to make the value connected with it comparatively unimportant. The analyses of the trichloride, being discordant, are here rejected.

By reducing the weighings published by Liechti and Kemp* to a common standard we get the following percentage results. In $MoCl_2$ the subjoined quantities of the original substance and of MoS_2 correspond to 100 parts of AgCl:—

$MoCl_2$.	MoS_2.
58·299	55·762
58·194	55·591
58·524	56·065
Mean 58·339 $\pm$ 0·066	Mean 55·806 $\pm$ 0·093

Hence $MoCl_2 = 166·902 \pm 0·188$, and $MoS_2 = 159·652 \pm 0·268$.

With the tetrachloride similarly calculated we get these figures, corresponding to 100 parts AgCl:—

$MoCl_4$.	MoS_2.
41·492	27·957
41·319	
Mean 41·4055 $\pm$ 0·0583	

Hence $MoCl_4 = 236·914 \pm 0·358$, and MoS_2, if given the weight of a single experiment in the dichloride series, $= 159·964 \pm 0·627$.

For the pentachloride the following quantities balance 100 of AgCl:—

$MoCl_5$.	MoS_2.
38·168	22·428
38·057	22·289
Mean 38·112 $\pm$ 0·038	Mean 22·3585 $\pm$ 0·040

Hence $MoCl_5 = 272·587 \pm 0·271$, and $MoS_2 = 159·914 \pm 0·287$.

We have now the molecular weight of each chloride, and three values for that of the disulphide. Combining the latter we get a general mean, as follows:—

From $MoCl_2$ series ..	MoS_2 =	159·652 $\pm$	0·268
,, $MoCl_4$,, ..	,,	159·964	0·627
,, $MoCl_5$,, ..	,,	159·914	0·287
General mean ..	,,	159·790	0·187

With these data, in addition to those given by Dumas and by Debray, we get five estimates of the atomic weight of molybdenum:—

Dumas and Debray's data	Mo =	95·429 $\pm$	0·057
From molecular weight of $MoCl_2$..	,,	96·262	0·190
,, ,, $MoCl_4$..	,,	95·434	0·363
,, ,, $MoCl_5$..	,,	95·737	0·280
,, ,, MoS_2 ..	,,	95·816	0·188
General mean ..	,,	95·527	0·051

Or, if $O = 16$, $Mo = 95·747$.

It will at once be seen that the most reliable results are those obtained by the reduction of molybdenum trioxide. Traces of oxychlorides may possibly have contaminated the chlorides and augmented their atomic weight. Our final figure, therefore, may be a trifle too high, but the early value, 92, is unquestionably very far too low.

* *Journ. f. Prakt. Chem*, 49, 444. 1850.
† *Ann. Chem. Pharm.*, 105, 84, and 113, 23.
‡ *Compt. Rend.*, 66, 734.
|| *Ann. Chem. Pharm.*, 169, 365 1873.
§ *Ann. Chem. Pharm.*, 169, 344.

* These are as follows:—

0·2666 grm. $MoCl_2$ gave	0·2550 grm. MoS_2	and	0·4573 grm. AgCl.	
0·1811 ,,	0·1730	,,	0·3112	,,
0·2530 ,,	0·2422	,,	0·4320	,,
0·4126 grm. $MoCl_4$ gave	0·2780	,,	0·9944	,,
0·1923 ,,	—	,,	0·4654	,,
0·5810 grm. $MoCl_5$ gave	0·3414	,,	1·5222	,,
0·2466 ,,	0·1441	,,	0·6465	,,

Since the foregoing discussion was written, a single experiment by Rammelsberg* has been brought to my notice. Closely following Dumas's method, he reduced molybdenum trioxide to metal, finding in it 66·708 per cent of the latter. This figure comes within the limits of variation of Dumas's experiments, and therefore gives them additional confirmation. Its introduction into the general mean, however, would exert too little influence upon the latter to justify the labour of recalculation.

THE CHEMICAL WORK OF WÖHLER.*

By Professor THORPE, F R.S.

It seems fitting that these walls which have vibrated in sympathy with that brilliant eulogy of Liebig, which Professor Hofmann pronounced some nine years ago, should hear something of him whose life-long association with Liebig has exercised an undying influence on the development of scientific thought. The names of Frederick Wöhler and Justus Liebig will be linked together throughout all time. The work which they did in common makes an epoch in the history of chemistry. No truer indication of the singular strength and beauty of their relations could be given than is contained in a letter from Liebig to Wöhler written on the last day of the year 1871. "I cannot let the year pass away," writes Liebig to Wöhler, "without giving thee one more sign of my existence, and again expressing my heart-felt wishes for thy welfare and the welfare of those that are dear to thee. We shall not for long be able to send each other new year's greetings, yet, when we are dead and mouldering, the ties which have united us in life will still hold us together in the memory of men as a not too frequent example of faithful workers, who, without envy or jealousy, have zealously laboured in same field, linked together in the closest friendship."

And yet, bound as they were in the ties of a friendship whose purity and warmth were but characteristic of the men, and although each influenced the other's walk and work in life to a degree which it is almost impossible to gauge, such was the strength of their individuality, and such the force of their genius, that, without a doubt, either would have been a great figure in the history of science if the other had not existed.

The conditions under which minds of the highest type arise and develop have on more than one occasion engaged the attention of this audience. Although there were circumstances in Wöhler's surroundings which in early life may have influenced the bent of his mind, it is not easy to see whence spring that passionate love of nature which was so strikingly exhibited in the man. His father, August Anton Wöhler, was formerly an equerry in the service of the elector William II. of Hesse; he afterwards came to live at Frankfort and became a leading citizen of that town. His wise liberality and public spirit are commemorated in the Wöhler-Foundation, and Wöhler-School, institutions known to every Frankforter. His mother was connected by marriage with the minister of Eschersheim, a village near Frankfort, and it was in the minister's house that Frederick Wöhler first saw the light on the 31st July, 1800. Even in early youth his passion for experimenting and collecting manifested itself to the neglect, not unfrequently, of the lessons of the Gymnasium; indeed it would appear that during his school career Wöhler was not characterised by either special diligence or knowledge. The bent of his mind towards natural science was directed by Dr. Buch, a retired physician, who had devoted himself to the study of chemistry and physics; and it was in the kitchen of his patron's house that he prepared the then newly discovered element selenium, of which an account was afterwards sent by Dr. Buch to *Gilbert's Annalen*, with Wöhler's name at the head of it. The elder Wöhler appears to have been a man of considerable artistic feeling, and under his direction, the son was taught sketching and otherwise educated in that perception of natural beauty which comes out so strikingly in his after life; he was encouraged to make himself familiar with the literature which the genius of Schiller and Gœthe has ennobled. He had moreover to thank his father for that love of physical exercise and passion for out-door life which reacted so markedly upon his development, and contributed so largely to the uniformly good health which he enjoyed to within a few days of his death.

Mainly, it would seem, because his father had been there before him, Wöhler, in his 20th year, entered the University of Marburg. It was his own and the family's wish that he should study medicine, and he accordingly put his name down for the lectures of Bünger on Anatomy, Gerling on Physics and Mathematics, and Wenderoth on Botany. He found time also to attend Ullmann's classes on mineralogy, and although he declined to hear the lectures on chemistry, he by no means neglected that science. He transformed his living room into a laboratory, and to the great, and perhaps not undeserved disgust of his landlady, occupied himself with the preparation and study of the properties of prussic acid, thiocyanic acid, and other cyanogen compounds. He discovered at that time, without knowing that Sir Humphry Davy had anticipated him, the beautifully crystalline, but intensely poisonous, iodide of cyanogen, and in the little paper on cyanogen compounds, which his good friend Dr. Buch communicated to *Gilbert's Annalen* for him, we have the first description of the remarkable behaviour of mercuric thiocyanate on heating, which has astonished and amused us in the so-called "Pharaoh's Serpent."

Wöhler, attracted by the fame of Leopold Gmelin, left Marburg for Heidelberg. His main idea was to hear the lectures of that distinguished man, but Gmelin declared this to be unnecessary and a waste of time. Wöhler in fact never attended any systematic lectures on Chemistry. He had access, however, to the old cloisters which at that time constituted the Heidelberg Laboratory, and there began the work on cyanic acid which some four or five years later was destined to culminate in the great discovery of the synthesis of urea. His association at this time with Tiedemann, who was engaged in physiological chemical investigations with Gmelin, had also considerable influence in determining the direction of much of his future work, whilst its immediate effect was the publication in Tiedemann's *Zeitschrift fur Physiologie* of the results of an inquiry into the transformation experienced by various substances, organic and inorganic, in their passage through the organism. In 1823 Wöhler obtained his degree, when, on Gmelin's advice, he determined to follow his master's example and abandon medicine for chemistry. At that time the great Swedish chemist, Berzelius, was at the summit of his fame. His masterly analytical skill, no less than his labours towards the development of chemical theory, had made him supreme among the chemists of Europe and Stockholm; therefore to him Wöhler, acting on the advice of Gmelin, determined to go. He was warmly welcomed by Berzelius, on whom his communications to *Gilbert's Annalen* had made a favourable impression, and with the offer of a place in the private laboratory of the illustrious Swede, Wöhler set out for the Scandinavian capital. Of his experience with Berzelius his pupil has left us a delightful occount. It is valuable not only as a charming character sketch of the great teacher, but also from the side-light it throws upon the nature and disposition of Wöhler himself. It is interesting, too, as an account of the mode in which Berzelius worked and taught and as showing how the typical laboratory of that

* *Berlin Monatsbericht*, 1877, 574.

* A Lecture delivered in the Royal Institution on Friday evening, Feb. 15th.

time contrasted with the temples which have since been reared by the disciples of Hermes. "With a beating heart," says Wöhler, "I stood before Berzelius's door and rang the bell. It was opened by a well-clad, portly, vigorous looking-man. It was Berzelius himself. . . . As he led me into his laboratory I was as in a dream, doubting if I could really be in the classical place which was the object of my aspirations. . . . I was at that time the only one in the laboratory: before me were Mitscherlich and Heinrich and Gustav Rose: after me came Magnus. The laboratory consisted of two ordinary rooms furnished in the simplest possible way; there were no furnaces nor draught places; neither gas nor water service. In one of the rooms were two common deal tables; on one of these worked Berzelius; the other was intended for me. On the walls were a few cupboards for the reagents; in the middle was a mercury trough, whilst the glass-blowers, lamp stood on the hearth. In addition was a sink consisting of an earthenware cistern and tap standing over a wooden tub, where the despotic Anna, the cook, had daily to clean the apparatus. In the other room were the balances, and some cupboards containing instruments: close to was a small workshop fitted with a lathe. In the neighbouring kitchen, in which Anna prepared the meals, was a small but seldom-used furnace and the never-cool sand-bath."

Wöhler's first exercises were in mineral analysis, in order that he might become acquainted with Berzelius's special methods and manipulative procedure. At that time he prepared, among other products, some new compounds of tungsten, notably the beautifully crystallised monoxychloride and the tungsten sodium-bronze ($Na_2W_3O_9$), which some twenty-five years later was introduced into commerce as a bronze-powder. It was, however, with his investigation on cyanic acid that both he and Berzelius were mainly interested. In Berzelius's opinion, the existence of this body was of importance from the light it seemed to him to throw upon the validity of the new chlorine theory. "I was surprised," says Wöhler, "to hear him, the hitherto stedfast upholder of the old notion, now always talk of *chlorine* instead of oxidised hydrochloric acid. Once when Anna, in cleaning some vessel, remarked that it smelled strongly of oxymuriatic acid, Berzelius said, 'Hearest thou, Anna, thou must no longer speak of oxidised muriatic acid: thou must call it *chlorine*: that is better.'" With what feelings would Davy have listened to that colloquy between the Swedish philosopher and his factotum! Chlorine was discovered by Berzelius's illustrious countryman, Scheele, but its true nature was first demonstrated in the laboratory of the Royal Institution.

A couple of months were now spent in travel with Berzelius, in company with the two Brongniarts,—Alexander, the geologist, and Adolph, the botanist—during which they explored the greater portion of the geologically interesting parts of Southern Sweden and Norway, and collected rich stores of those wonderful minerals for which Scandinavia is famous. Scandinavia is no less famous for salmon and trout, and it was on his return from a fishing expedition in Norway that the travellers met with Davy, who, as readers of Salmonia know, handled his rod with equal zest and zeal. Wöhler, who as a boy had learned the story from his friend, Dr. Buch, of the isolation of the alkaline metals by Davy, and who, aided by his little sister, whose business it was to blow the bellows, had toiled, not unsuccessfully, to make potassium in the kitchen fire, was presented to the famous chemist.

On the return to Stockholm Wöhler took leave of Berzelius, and prepared to return to Germany. Of his association with this great man Wöhler had ever the kindliest memories. Although the outcome of much of his subsequent work—or at least much of that which he did in concert with Liebig—might be said to bring him in occasional conflict with Berzelius's cherished convictions on points of chemical theory, the master and pupil remained to the end bound together in warmest friendship. Scarcely a month passed without an exchange of letters. Those from Berzelius were religiously preserved by Wöhler, who after Berzelius's death in 1848 presented them, to the extent of some hundreds, to the Swedish Academy of Science. We are told that in the later letters the "trauliche du" appears in place of the more formal "Sie," and that "*totus et tantus tuus*" is a not unfrequent signature. Wöhler's gratitude and almost filial reverence are seen in the circumstance that even in the full tide of his vigour, and when time was doubly precious to him, he continued to charge himself with the yearly translation of Berzelius's *Jahresbericht* into German. It is easy to trace the influence of Wöhler's contact with Berzelius in this after-work. To begin with the men had much in common. Their sympathies were as catholic as science itself, and they ranged at will over every department of chemical knowledge. Wöhler attacked the composition of a mineral with as much ardour as he did the preparation of an organic compound: to him the problems of physiological chemistry were not more important than the isolation of a rare earth or the perfection of some analytical method. The artificial barriers and fancied lines of demarcation in the science seemed to have no existence for Wöhler. Indeed, it was the crowning triumph of his work to break down such barriers almost at a stroke, and to demonstrate the irrationality of these attempts to draw distinctions regardless of differences. The history of chemistry is indeed like that of the nation which has done so much to advance it: its unity to-day is as complete as that of Germany itself.

Wöhler was now to embark on his academic career, and, under the advice of Gmelin and Tiedemann, he prepared to settle in Heidelberg as "Privat-docent." But to Heidelberg he was not destined to go. His worth had already been gauged by such men as Leopold von Buch, Poggendorff, and Mitscherlich, and these, without his knowledge, had strongly recommended his election to the vacant teachership of chemistry in the newly-founded Trade School in Berlin. Berzelius advised him to accept the post, and to Berlin accordingly Wöhler went in 1825. He was now in possession of a laboratory which he could call his own, and he had to justify that possession by the use which he made of it. One of the problems which he now attacked was the isolation of *aluminium*—a metallic radicle more abundant and more widely diffused than any other of the fifty bodies we are accustomed to designate as metals. He succeeded in obtaining the body by the method which nearly twenty years after was worked out on a manufacturing scale by Sainte-Claire Deville. Deville caused the first bar of the metal thus procured to be struck as a medal with the image of Napoleon III. on the one side and the name Wöhler with the date 1827 on the other, and some time after the Emperor simultaneously designated the two chemists Officers of the Legion of Honour. But of the 22 memoirs and papers which *Poggendorff's Annalen* exhibits as the outcome of Wöhler's activity and power of work during his six years' stay in Berlin, that on the artificial formation of urea is by far the most important. No single chemical discovery of this century has exercised so great an influence on the development of scientific thought, and the words with which Wöhler closes his account of the molecular transformation of ammonium cyanate, a body of purely inorganic origin, into urea,—a substance which of all that might be named is the most characteristic of the action of the so-called vital force—a force which some would have us believe rises superior to all forms of energy, inasmuch as it is untrammelled by the laws which regulate their action—are full of meaning. "This unexpected result," he says, "is a remarkable fact, in so far as it presents an example of the artificial formation of an organic body, and, indeed, one of animal origin out of inorganic materials."

"The synthesis of urea," says Professor Hofmann in his account of Wöhler's life-work, "was an epoch-making discovery in the real sense of that word. With it was

opened out a new domain of investigation, upon which the chemist instantly seized. The present generation, which is constantly gathering such rich harvests from the territory won for it by Wöhler, can only with difficulty transport itself back to that remote period in which the creation of an organic compound within the body of a plant or an animal appeared to be conditioned in some mysterious way by the vital force, and they can hardly realise the impression which the building up of urea from its elements then made upon men's minds. And yet it cannot be said that chemists were unprepared for this discovery. Such a consummation was indicated years before by the results of chemical activity. Men were long ago in the habit of perceiving that bodies of mineral origin were but the types of those met with in the animal and vegetable organism. In both classes there were the same differences in states of aggregation, the same mutual transformations, the same crystalline forms, the same constancy in combining relations, the same conjunction of the elements according to the weights of their atoms or in multiples of these, in both classes the appearance of the same species of compounds! But all attempts to build up organic compounds from their elements, as this for a large number of mineral substances had already been done, had hitherto been futile. The chemists of that period had nevertheless the presentiment that even this barrier must fall, and one can conceive the feeling of joy with which the gospel of a new unified chemistry was hailed by the intellect of that time. With the revolution thus effected in the ideas of men, Science was directed into new paths and unto new goals. Who does not know with what zeal these paths have been trodden, and how many of these goals have been reached!"

But if at this time Wöhler made a great discovery for us and for all men, he also, at about the same time, made a great discovery for himself: he discovered Liebig. The manner in which the two men were brought together is worth mentioning, for it would seem almost as if the hand of destiny was in it. At about the time that Wöhler was at Stockholm, thinking and working on cyanic acid, Liebig was at Paris engaged with Gay-Lussac on the study of the metallic compounds of an acid which, on account of their formidable explosive properties, has received the not inappropriate name of fulminic acid. Liebig, with rare skill and courage, had determined the composition of that acid, and had been rewarded by the honour of a waltz with Gay-Lussac, it being the habit of that distinguished philosopher, as he explained to the astonished young German doctor, to express his ecstasy on the occasion of a new discovery in the poetry of motion. But the most extraordinary result of that investigation was to show that the terribly explosive fulminic acid and innocuous cyanic acid were of identical composition. The idea that bodies could exist of identical ultimate composition—that is, composed of the same elements united in the same proportion and yet possess essentially different properties; in other words, be absolutely dissimilar things—was new to science Berzelius, the great chemical law giver of his time, scouted the notion as absurd; to him it was impossible to conceive that identity in elementary composition should not result in identity of properties. And yet, later on, Berzelius was forced to realise the fact by the discovery of his pupil Wöhler of the molecular transformation of ammonium cyanate into urea, and to coin for us the word *isomerism* by which that fact is denoted.

It was thus from the singular circumstance that Wöhler and Liebig were at the outset of their career engaged upon the elucidation of the nature of two bodies of identical composition but of dissimilar origin, dissimilar relations, and very different properties, that they were brought into juxtaposition. They desired to know each other; they met in the house of a mutual friend at Frankfort, and the names of Liebig and Wöhler became henceforth linked together for all time.

The origin of that partnership, so fruitful in consequences for science, may be seen in the following characteristic letter:—

"Freedrick Wöhler to Justus Liebig.

"Saerow, near Potsdam, June 8th, 1829.

"Dear Professor,—The content of your last letter to Poggendorff has been communcated to me by him, and I am glad that it affords me an opportunity of resuming the correspondence which we began last winter. It must surely be some wicked demon that again and again imperceptibly brings us into collision with our work, and tries to make the chemical public believe that we purposely seek as opponents these apples of discord. But I think he is not going to succeed. If you are so minded we might, for the fun of it, undertake some chemical work together, in order that the results might be made known under our joint names. Of course, you would work in Giessen and I in Berlin, after we were agreed upon the plan and had communicated with each other from time to time as to its progress. I leave the choice of subject entirely to you.

"I am very glad that you have also determined the identity of pyruvic and cyanic [cyanuric] acids. L. Gmelin would say: 'God be thanked, there is one acid the less!' . . . .

"Yours, Wöhler."

Liebig acceded to the proposition at once, and suggested some problem on the chemical nature of nitrogen; this Wöhler found himself unable to undertake as it involved the use of chlorine, to the action of which he was at all times extremely susceptible. On the other hand, he proposed to Liebig that they should continue in common a research on mellitic acid which he himself had begun. Their joint investigation on this body made its appearance within the following year.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, Vol. 16, No. 7.

Formation of Sulphides by Pressure; Considerations on the Chemical Nature of Red Phosphorus and of Amorphous Carbon.—W. Spring.—By subjecting mixtures of the respective substances to a pressure of 6500 atmospheres, the author obtained magnesium, zinc, iron, cadmium, bismuth, lead, silver, copper, tin, and antimony sulphides. With aluminium the result appears doubtful. Sulphur could not be combined in this manner wlth red phosphorus or with carbon. Hence he concludes that polymerisation checks the chemical affinities of any element. The readiness with which certain bodies enter into combination depends on a certain allotropic condition, which finds its explanation in the mobility of the atoms. The more a body is condensed in the solid state, the more its chemical functions are interfered with. The question arises whether carbon, as met with in organised bodies, does not exist in an allotropic condition, not as yet known. This condition may be characterised by the possession of other properties and the power of forming new kinds of compounds, which find their expression in the vital process. Hence organic carbon is the first stage of degradation of organic chemistry, whilst ordinary carbon is merely the powerless residuum of organic chemistry.

A New Tellurium Oxide.—E. Divers and M. Shimosé.—The new compound may be regarded according to its composition as tellurium monoxide. It is permanent in dry air at the common temperature. Its colour is black, with a brownish reflection. If heated strongly in a vacuum it is resolved into tellurium dioxide and free tellurium. It

is slowly attacked by cold potassa lye, but acids, even when cold and dilute, act on it rapidly.

Tellurium Sulphoxide.—E. Divers and M. Shimosé. —The authors describe two modifications of this compound, a red, and a brown. The former they regard as a tellurium sulphonate, containing tellurium in an instable bivalent condition, whilst the brown is a more permanent compound of the oxides of the two elements, both quadrivalent. The red form is converted into the brown when heated in a vacuum to 90°. The ultimate composition of each form is SO_3Te.

The Occurrence of Free Tartaric Acid in Wine, and its Determination.—A. Claus.—The author proves the existence of free tartaric acid as a normal constituent of wine. He proposes to extract this acid from the residue of evaporation, not with ether, but with absolute alcohol. The wine must have been previously evaporated to dryness, and the residue kept for some time at 110° in the air-bath.

Methylene Blue.—A. Bernthsen.—A preliminary communication. The blue contains to C_{16}, not 4, but 3 atoms of N, By reducing this colouring-matter with sodium hydrosulphite, the author has obtained a leuko base, methylene-white, which is capable of forming methyl and acetyl compounds.

Condensation-products of Œnanthol.—W. H. Perkin.—The author examines the action of nascent hydrogen upon œnanthol in an acid and in an ethereal solution. In the latter case the products are heptylic alcohol and heptylic acid.

Polymerisation of Œnanthol.—W. H. Perkin.—This memoir is given in detail in the *Journal of the Chemical Society*.

Action of the Halogenous Substitutes of the Fatty Acids upon Aniline.—C. A. Bischoff.—If a mixture of 1 mol. aniline and 1 mol. chloracetester is slowly heated in a cohobator to above the boiling-point of aniline hydrochlorate, the crystals of phenyl-glycin-ethyl-ester formed in the cold are first melted; the mass then boils, and on distilling off there passes over first unchanged chloracetester, streams of hydrochloric acid and some water, and aniline hydrochlorate. The remaining reddish oily matter congeals on cooling to a brittle glassy substance, which may be readily powdered, and is then bright yellow and very permanent in the air. The reaction of brom-propionic ester is similar. In that of β-chlor-α-hydroxypropionic ester the temperature must be regulated in a different manner.

Synthesis of Ketonic Acids of the Aromatic Series and of Polybasic Acids of the Fatty Series.—C. A. Bischoff.—A preliminary communication.

Remark.—C. Böttinger.—The author points out an inaccuracy in J. M. Lovin's paper on certain substitution-products of lactic acid.

Action of Ethyl-dichloramine upon Aromatic Amines and Hydrazo-benzol.—A. Pierson and K. Heumann.—The authors have studied the behaviour of ethyl-dichloramine with para-toluidine, when para-azotoluol is formed along with ethylamine hydrochlorate; also of ethyl-dichloramine with aniline, the results being trichloraniline and dichloraniline; also of ethyl-dichloraniline with hydrazo-benzol, when the products were azobenzol and ethylamine hydrochlorate.

A Simplification of Victor Meyer's Method of Determining Vapour Densities.—H. Schwarz.—This memoir requires the accompanying illustration.

The Action of Dibrom-barbituric Acid upon Sulphourea and the Sulpho-cyanides.—W. Trzcinski.—The behaviour of dibrom-barbituric acid with sulphurea and the sulphocyanides is different from that of the dibrom-pyruvic and dibrom-succinic acids. The bromine is eliminated, and there is substituted for it a molecule of sulphurea or of a metallic sulpho-cyanide.

Dicyan-diamide.—E. Bamberger.—An investigation of the chemical character of this compound, with the view of ascertaining whether it is a guanidine in which 2 atoms of hydrogen are replaced by the bivalent radicle carbimide, or a guanidine in which cyanogen plays the part of an amide hydrogen.

A New Acid in the Juice of Beet-root.—E. O. v. Lippmann.—The new compound, $C_6H_8O_8$, is a powerful tribasic acid, forming soluble salts with the alkalies, and, with baryta, white granules, insoluble in water and alcohol. It has a close resemblance to the oxy-citric acid of Pawolleck.

Certain Fluorene Derivatives.—J. Holm.—The author has obtained dibrom-phenylen-keton by the oxidation of dibrom-fluorene. Dibrom-fluorene-keton is converted by the action of melting potassa into dibrom-phenyl-benzoic acid. The oxidation of tribrom-fluorene yields the same β-dibrom-diphenylen-keton as does bibrom-fluorene. Trichlor-fluorene was obtained by passing chlorine slowly into a solution of fluorene in carbon disulphide.

Chinoline of Coal-tar.—E. Jacobsen and C. L. Reimer. —The chinoline-yellow of the authors is obtained from coal-tar, whilst that of Traub is prepared from cinchonine. Chinoline-yellow, $C_{17}H_9NO_2$, is not a base; it dissolves in strong sulphuric acid, but on the addition of water it is deposited quite free from sulphuric acid.

Air-baths.—Lothar Meyer.—This paper cannot be reproduced without the six accompanying figures.

MISCELLANEOUS.

Royal Institution.—Professor Tyndall will begin a Course of Six Lectures on "The Older Electricity—its Phenomena and Investigators," on Thursday next (Feb 28), illustrated by experiments; and Captain Abney, R.E., will begin a Course of Six Lectures on Photographic Action, considered as the Work of Radiation," on Saturday (March 1). Professor Hughes will give a discourse on Friday evening next on "Theory of Magnetism," illustrated by experiments.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Colours for Leather Staining.—Could any of your numerous readers inform me where I could obtain a good monograph (book) on colours, principally for leather staining? I shall be much obliged for the information.—C. W. S.

MEETINGS FOR THE WEEK

Monday, Feb. 25th.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "Building of London Houses," by Robert W. Edis, F.S.A.
Tuesday, 26th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.
— Society of Arts, 8. "Reflections on Chinese History, with reference to the Present Situation of Affairs," by Demetrius G. Boulger.
Wednesday, 27th.—Society of Arts, 8. "Internal Corrosion and Scale in Steam-Boilers," by G. Swinburne King.
Thursday, 28th.—Royal, 4.30.
— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
— London Institution, 7.
— Society of Arts, 8. "Recent Progress in Dynamo-Electric Machinery," by Prof. Silvanus P. Thompson.
Friday, 29th.—Royal Institution, 8. "Theory of Magnetism," by Prof. Hughes, at 9.
Saturday, March 1.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

THE CHEMICAL NEWS.

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ON THE OCCURRENCE OF PHENOL IN THE STEM, LEAVES, AND CONES OF *PINUS SYLVESTRIS*.

A DISCOVERY BEARING ON THE FLORA OF THE CARBONIFEROUS EPOCH AND THE FORMATION OF PETROLEUM.

By A. B. GRIFFITHS, Ph.D., F.C.S.,
Membre de la Société Chimique de Paris, Medallist in Chemistry and Botany, &c.

HAVING found, in small quantities, alcohols of the C_nH_{2n-7} series, last summer, in the stem, acicular leaves, and cones of *Pinus sylvestris*, I wish in this paper to say a few words on the subject.

First of all, I took a number of cones, cut them up into small pieces, and placed them in a large glass beaker, then nearly filled it with distilled water, and heated to about 80° C., keeping the decoction at this temperature for about half an hour, I occasionally stirred with a glass rod, and then allowed it to cool, and filtered. This filtrate was then evaporated nearly to dryness, when a small quantity of six-sided prisms crystallised out, which subsequently were found to be the hydrate of phenol, $(C_6H_5Ho)_2H_2O$. Its melting-point was found to be 17·2° C. Further, the crystals already referred to were dissolved in ether, and then allowed to evaporate, when long colourless needles were obtained, which, on being placed in a dry test-tube and the tube placed in a water-bath kept at 42° C., were found to melt, and on making a careful combustion analysis of these crystals, the following composition was obtained:—

Carbon	76·6
Hydrogen	6·4
Oxygen	17·0
	100·0

This gives C_6H_6O, which is the formula for phenol.

On dissolving some of these crystals in water (excess) and adding ferric chloride, a beautiful violet colour was imparted to the solution. To another aqueous solution of the crystals was added bromine water, and a white precipitate was obtained, consisting of tribromo-phenol. An aqueous solution of the crystals immediately coagulated albumen.

All these reactions show that the phenol occurs in the free state in the cones of this plant. In the same manner I treated the acicular leaves, and portions of the stem separately, both being previously cut up into small pieces, and from both I obtained phenol.

I have ascertained the relative amount of phenol in each part of the plant operated upon: by heating the stem with water at 80° C. and filtering, and repeating this operation until the aqueous filtrate gave no violet colour with ferric chloride and no white precipitate with bromine water.

I found various quantities according to the age of the stem. The older portions yielding as much as 0·1021 per cent, while the young portions gave only 0·0654 per cent. The leaves yielding, according to their age, 0·0936 and 0·0315 per cent; and the cones also gave varying amounts according to their maturity, the amounts varying between 0·0774 and 0·0293.

Two methods were used in the quantitative estimation of the amount of phenol. The first was the new volumetric method of M. Chandelon (*Bulletin de la Société Chimique de Paris*, July 20, 1882; and *Deutsch-Amerikanische Apotheker Zeitung*, vol. iii., No. 12, September 1, 1882), which I have found to be very satisfactory. The process depends on the precipitation of phenol by a dilute aqueous solution of bromine as tribromo-phenol. The second method was to extract, as already stated, a known weight of each part of the plant with water, until the last extract gives *no* violet colour with ferric chloride, and no white precipitate with the bromine test (which is capable of detecting in a solution the 1-60.000th part of phenol). The aqueous extract is at this point evaporated, then ether is added, and finally the ethereal solution is allowed to evaporate. The residue (phenol) is weighed directly, and from this the percentage can be ascertained. By this method of extraction, the oil of turpentine, resins, &c., contained in *Pinus sylvestris* do not pass into solution, because they are insoluble in water, even when boiling; what passes into solution besides phenol is a little tannin, which is practically insoluble in ether.

From this investigation it will be seen that phenol exists in various proportions in the free state in the leaves, stem, and cones of *Pinus sylvestris*, and as this compound is a product in the distillation of coal, and as geologists have to a certain extent direct evidence that the flora of the carboniferous epoch was essentially cryptogamous, the only phænogamous plants which constituted any feature in "the coal forests" being the coniferæ, and as coal is the fossil remains of that gigantic flora which contained phenol, I think my discovery of phenol in the coniferæ of the present day, further supports, from a chemical point of view, the views of geologists that the coniferæ existed so far back in the world's history as the carboniferous age.

I think this discovery also supports the theory that the origin of petroleum in nature is produced by moderate heat on coal or similar matter of a vegetable origin. For we know from the researches of Freund and Pebal (*Ann. Chem. Pharm.*, cxv., 19) that petroleum contains phenol and its homologues, and as I have found this organic compound in the coniferæ of to-day, it is probable that petroleum in certain areas has been produced from the conifers and the flora generally of some primæval forests. It is stated by numerous chemists that "petroleum almost always contains solid paraffin" and similar hydrocarbons. Professors Schorlemmer and Thorpe have found heptane in Pinus, which heptane yielded primary heptyl-alcohol and methyl-pentyl-carbinol, exactly as the heptane obtained from petroleum does (*Annalen de Chemie*, ccxvii., 149, and clxxxviii., 249; and *Berichte der Deutschen Chemischen Gesellschaft*, xiii., 1649); and, further, petroleum contains a large number of hydrocarbons which are found in coal. Again, Mendelejeff, Beilstein, and others (*Bulletin de la Société Chimique de Paris*, No. 1, July 5, 1883), have found hydrocarbons of the—

$$C_nH_{2n+2}, C_nH_{2n-6},$$

also hydrocarbons of the C_nH_{2n} series in the petroleum of Baku, American petroleum containing similar hydrocarbons.

I think all these facts give very great weight to the theory that petroleum is of organic origin.

On the other hand, Berthelot (from his synthetic production of hydrocarbons) believes that the interior of the globe contains alkaline metals in the *free* state, which yield acetylides in the presence of carbonic anhydride, which are decomposed into acetylene by aqueous vapour. But it has been already proved that acetylene may be polymerised, so as to produce aromatic carbides, or the derivatives of marsh-gas, by the absorption of hydrogen. Berthelot's view, therefore, is too imaginative; for the presence of *free* alkaline metals in the earth's interior is an unproved and very improbable hypothesis. Byasson states that petroleum is formed by the action of water, carbonic anhydride, and sulphuretted hydrogen upon incandescent iron. Mendelejeff thinks it is formed by the action of aqueous vapour upon carbides of iron; and in his article, "Petroleum, the Light of the Poor" (in this

month's, February, number of *Good Words*), Sir Lyon Playfair, K.C.B., F.R.S., &c., holds opinions similar to those of Mendelejeff.

Taking in consideration the facts that solid paraffin is found in petroleum and is also found in coal, and from my own work that phenol exists in *Pinus sylvestris*, and has been found by others in coal which is produced from the decomposition of a flora containing numerous gigantic coniferæ allied to Pinus, and that petroleum contains phenol, and each (*i.e.*, petroleum and coal) contains a number of hydrocarbons common to both, I am inclined to think that the balance of evidence is in favour of the hypothesis that petroleum has been produced in nature from a vegetable source in the interior of the globe. Of course, there can be no practical or direct evidence as to the origin of petroleum; therefore "theories are the only lights with which we can penetrate the obscurity of the unknown, and they are to be valued just as far as they illuminate our path."

In conclusion I think that there is a connecting link between the old pine and fir forest of bygone ages and the origin of petroleum in nature.

THE CHEMICAL WORK OF WÖHLER.*

By Professor THORPE, F R.S.

(Concluded from p. 93).

It would be quite impossible within the limits of an hour to attempt to give you anything approaching a complete analysis of Wöhler's work. Wöhler was the author of 275 memoirs and papers, and of these 15 were published in concert with Liebig. I must therefore confine my selection from this vast amount of material to those papers which are of paramount importance from the influence which they have exerted on chemical theory or on the development of the chemical arts.

Very shortly after the publication of the work on mellitic acid, Wöhler proposed to Liebig a joint investigation on cyanuric acid, in the course of which he observed the extraordinary transformation of that acid into cyanic acid, and the re-conversion of the cyanic acid into cyanuric acid—one of the most remarkable instances of molecular rearrangement known to the chemist. The work progressed little for some months, owing to the demands made by *Berzelius's Jahresbericht* on Wöhler's time. "Wirf die Schreiberei zum Teufel," wrote Liebig, "und gehe in das Laboratorium, wohn Du Gehörst."

It was that functionary, doubtless, who in due time carried off the writing to his master the printer. Wöhler went back to his laboratory, and in a few weeks the two investigators had obtained the clue to the puzzle. Liebig wrote to Wöhler—"Now that I have received your experiments the whole thing is cleared up, and with what satisfaction for us! The matter is now decided: the cyanic acid of Serullas is identical with that from urea......Ich bin ganz nämsch vor Freude, dars unser Kindlein hun fehlerers in die Welt geretzwird, ohne Buckel oder Klumpfuss." [It had been suggested to attack the fulminic acid again.] "The fulminic acid we will allow to remain undisturbed. Like you, I have vowed to have nothing more to do with this stuff. Some time back I wanted, in connection with our work, to decompose some fulminating silver of means by ammonium sulphide: at the moment the first drop fell into the dish the mass exploded under my nose. I was thrown backwards, and was deaf for a fortnight, and became almost blind."

The work on cyanic acid appeared in *Poggendorff's Annalen* during the last month of 1830, and Wöhler was able to send the "Kindlein un Neuem Kleide," as he says, with a new year's greeting to his friend. Liebig had suggested fresh work, but at the moment Wöhler was in no humour to attack anything organic. The Swedish chemist Sefström had just announced the existence of a new element in the slag of certain iron ores, and this very substance had slipped through Wöhler's fingers unperceived. "I was an ass," he wrote to his friend, "not to have detected it two years ago in the lead ore from Zimapan, in Mexico. I was busy with its analysis, and had found something strange in it, when I was laid up for some months in consequence of breathing hydrofluoric acid fumes, and so the matter was allowed to rest. Meanwhile Berzelius sends me word of its discovery by Sefström in Swedish bar iron and in slag. It is very like chromium, and just as remarkable. Moreover, it is the same metal that Del Rio found in the Mexican lead ore and called Erythronium: Descotils, however, had declared this ore to be lead chromate."

Wöhler, no doubt, found a ready sympathiser in Liebig, to whom, not many years before, a similar experience had happened. We all know the story of the young chemist whose unscientific use of the imagination cost him the discovery of the element *bromine*. Wöhler had sent some of the substance to Stockholm, and Berzelius wrote as follows:—

"Stockholm, Jan. 22, 1831.

"As to the small quantity of the body marked (?) I will relate the following story:—'In the far North there lived in the olden time the goddess Vanadis, beautiful and gracious. One day there came a knock at her door. The goddess was in no hurry, and thought, "They can knock again": but there came no further knock, for he who had knocked had passed on. The goddess, wondering who it could be that cared so little to be let in, ran to the window and recognised the departing one. "Ah!" said she to herself, "It is that lazy fellow, Wöhler! He richly deserves his name since he cares so little to come in." Some days after some one else knocked, repeatedly and loud. The goddess opened the door herself: it was Sefström who entered, and as a consequence of their meeting Vanadium came to light.

"Your specimen with the (?) is, in fact, vanadium oxide. But he that has found the mode of artificially forming an organic body can well renounce the discovery of a new metal; indeed, one might have discovered ten unknown elements without as much skill as attaches to the masterly work which you and Liebig have carried out together, and first communicated to the scientific world."

In 1831 Wöhler was called from Berlin to Cassel, and for some little time he was wholly engaged in the planning and erection of his new laboratory at the Gewerbe School in that town. In the spring of the following year he was again ready for a new research, and this time it was to be the finest piece of work that the two investigators jointly engaged in. It was, in fact, to be the classical research on Bitter Almond Oil. On the 16th of May, 1832, Wöhler wrote to Liebig:—"Ich sehne mich nach einer ernsten Arbeit, sollten wir nicht die Confusion mit dern Bittermandelöl ins Reine bringen? Aber woher Material?"

It must have been a *forscherblick* amounting to inspiration which led Wöhler to take up this subject. But neither he nor Liebig could have been wholly conscious of the consequences which were to follow up their work. To-day, oil of bitter almonds is made artificially in Germany by the hundredweight. At that time the investigators could only obtain it in small quantities from Paris; they had, indeed, to thank Pelouze for the material with which they worked. Wöhler made this, his greatest research, under the cloud of a great sorrow: after barely two years of married life he lost his wife. Liebig, in the tenderest manner, brought him over to Geissen, and sought to wean him from his grief and the sense of his loneliness by his company and the wholesome distraction of their joint work made side by side.

On the 30th of August, 1832, Wöhler wrote to Liebig from Cassel:—"I am here back again in my darkened

* A Lecture delivered in the Royal Institution on Friday evening, Feb 15th.

solitude. I do not know how I shall thank you for the affection with which you received me and kept me by you so long. How happy was I that we could work together face to face.

"I send you with this the memoir on bitter almond oil. The writing has taken me longer than I anticipated. I want you to read through the whole with the greatest care, and to notice particularly the numbers and formulæ. What does not please you alter at once. I have often felt that there was something not quite right, without being able to find what was right."

I shall not attempt to dwell upon the outcome of this great work. The investigation on the radicle of benzoic acid will ever remain one of the greatest achievements in the history of organic chemistry. The work was, indeed, epoch-making in the far-reaching nature of its consequences. It was full of facts and rich in the promise of new material: a veritable mine from which subsequent workers like Cannizzaro, Fehling, Piria, Stas, and Hlasiwetz have dug rich treasure. The immediate effect of the paper was to establish the doctrine of organic radicles by demonstrating the existence of groups of bodies which had their analogues and prototypes in inorganic chemistry. The concluding words of the memoir strike, in fact, the keynote of the whole investigation. "In once more reviewing and connecting together the relations described in this memoir," wrote Liebig and Wöhler, "we find that they may be grouped round a common nucleus, which preserves intact its nature and composition in its association with other bodies. This stability has induced us to regard this nucleus as a kind of compound element, and to propose for it the special name of Benzoyl."

Another significant feature in the memoir was that each of the substances described and correlated was the type of a distinct group of bodies, some of which were known, but of which the analogies and relations were unthought of. Others of these bodies were yet to be discovered—a matter of little difficulty when the modes of their origin had been indicated.

The effect of this memoir on the chemical world was instantaneous. Berzelius was delighted. "The fact put forward by you," he wrote to Wöhler and Liebig, "give rise to such considerations that they may well be regarded as the dawn of a new day in chemistry. On this account I would propose that this first-discovered radicle, composed of more than two elements, should be named *proin* (from πρωΐ, the beginning of day), or orthrin (from ὄρθρος, daybreak); terms from which names like *proic acid*, *orthric acid*, *proic chloride*, *orthric chloride*, *&c.*, could be readily derived." Berzelius further proposed to indicate the idea of the nucleus which was thus seen to function in these bodies by giving to benzoyl the symbol Bz.

Wöhler remained in Cassel for nearly five years. In the autumn of 1835 died Stromeyer, Professor of Chemistry in the University of Gottingen. Opinions were divided as to his successor: the choice lay between Liebig and Wöhler. Eventually Wöhler was selected, and entered on his work at Gottingen in the early part of 1836. He was succeeded at Cassel by Bunsen, who was at that time *privat docent* in Gottingen. In the October of the year Wöhler was again ready for fresh work. He writes to Liebig:—"I am like a hen which has laid an egg, and straightway sets up a great cackling. I have this morning found how oil of bitter almonds containing prussic acid may be obtained from amygdalin, and would propose that we jointly undertake the further investigation of the matter, as it is intimately related to the benzoyl research, and it would seem strange if either of us should work alone again in this field. Dem estässt sich gar nicht abschen wie weit es sich Erstreckt, und ich glaube es ist geuris fruehlbar, wenn es mit Deinem Mist gellüngst wird."

In a couple of days afterwards Wöhler was ready with the fundamental facts for the research, and had sketched out its plan. He writes:—"I have just made a most remarkable discovery in relation to the amygdalin. Since it appeared that bitter almond oil might be obtained from amygdalin it occurred to me that the one might be converted into the other by simply distilling almonds with water, by an action similar to that of a ferment upon sugar, the change in this case being due in all probability to the albumin in the almonds. And this idea seems to be completely established. The facts are as follows:—

"1. Amygdalin, dissolved in water and digested with a bruised sweet almond, begins almost immediately to smell of bitter almond oil, which after a time may be distilled off in such quantity that it would appear that the amygdalin was wholly transformed into it.

"2. A filtered emulsion of sweet almonds produces the same effect.

"3. A boiled emulsion of sweet almonds, in which, therefore, the albumin is coagulated, affords not the smallest trace of oil with amygdalin.

"4. Bruised sweet almonds, covered with alcohol, and freed therefrom by pressure, transform, as before, amygdalin into bitter almond oil.

"5. Bruised peas, or the albumin they contain, give no oil with amygdalin.

"There are three points therefore to be ascertained:—

(*a*) What is the substance in bitter or sweet almonds which in contact with amygdalin and water forms bitter almond oil?

(*b*) Is the action by double decomposition or catalytic, like that of a ferment?

(*c*) What is the other product which in all probability is formed in addition to the oil and prussic acid?"

The merest tyro in organic chemistry to-day is familiar wiih the broad features of this investigation, and knows the answers which Liebig was able to give to his friend's interrogatives. The third substance Liebig discovered to be sugar. Under the influence of a nitrogenised ferment, termed by Liebig and Wöhler *emulsin*, amygdalin in presence of water is decomposed into benzaldehyd (bitter almond oil), prussic acid, and sugar (glucose), thus:—

$$\underbrace{C_{20}H_{27}NO_{11}}_{\text{Amygdalin.}} + \underbrace{2H_2O}_{\text{Water.}} = \underbrace{C_7H_6O}_{\text{Benzaldehyd.}} + \underbrace{CNH}_{\text{Prussic Acid.}} + \underbrace{2C_6H_{12}O_6.}_{\text{Glucose.}}$$

It simply remains to explain why this reaction only occurs when the almonds are bruised and digested with water. Both the emulsin and the amygdalin exist together in the almonds, but are contained in separate cells, and are only brought into oontact by the rupture of the cell-walls and the solvent action of the water. Amygdalin was the prototype of a large and important group of substances classed together as the glucosides.

At the instigation of Wöhler, the friends again returned to the question of the chemical nature of uric acid, and the memoir which they eventually published on the subject is of the profoundest interest not only to the chemist but also to the physiologist. Uric acid, originally discovered by the illustrious Scheele, was shown in 1815, by William Prout, then a boy of 19, to be the main constituent of the solid excreta of reptiles. Other chemists had succeeded in obtaining various derivatives from it; indeed Prout himself had prepared from it the so-called purpuric acid or murexide—a substance which years after obtained a transitory importance in the arts as a colouring-matter. But nothing was known concerning the constitution of the body, or of its relations to its derivatives, until Wöhler and Liebig attacked the problem. The extraordinary mutability of uric acid, which had baffled and deceived previous investigators, was to Wöhler and Liebig the very clue to the labyrinth leading to a veritable treasure house, and the wonderful insight and rare analytical skill of these two great men were never more clearly indicated than in the way in which they trod this intricate maize. No fewer than fifteen new bodies were added to the list of chemical compounds, and these were correlated with the same masterly lucidity that was so strikingly exhibited

in the memoir on the radicle of benzoic acid. Some of the greatest triumphs of modern chemistry are seen in the synthesis of organic bodies; that organic chemistry was about to advance along this line was clearly foreseen by Wöhler and Liebig. In opening their account of this the last great work they did in common, they say:—"From this research the philosophy of chemistry will draw the conclusion that the ultimate synthetical formation of all organic bodies, in so far as they are not organised (in so weit sie nicht mehr dem organismus angehören), may be regarded as not only probable but as certain. Sugar, salicin, morphin will be artificially obtained. As yet we know nothing of the way by which this result is to be attained, inasmuch as the proximate materials for forming these bodies are unknown; but we shall come to know them."

Henceforth the friends worked but little in common. Liebig's energies were spent in other directions, and Wöhler turned his attention to inorganic chemistry. Time allows only the very briefest mention to be made of his more important discoveries in this department of the science. We have first his isolation of boron and the preparation of the compounds of boron with aluminium and nitrogen, work done in concert with his friend, Sainte-Claire Deville. The readiness with which boron unites with nitrogen, and the mode in which the compound may be decomposed, led Wöhler to a conception of the origin of boric acid and borax in the volcanic waters in which they are frequently found. In collaboration with Buff he discovered the spontaneously inflammable hydride of silicon, the analogue of marsh-gas the simplest of the hydrides of carbon, and thereby laid the foundation-stone of a superstructure which in time to come may only be less imposing than that built up of the compounds of carbon.

Many years ago Wollaston noted the presence of beautiful lustrous copper-coloured cubes in the slags from the iron blast-furnaces, which he assumed to be metallic titanium. Wöhler proved this substance to be a compound of carbon, nitrogen, and titanium, and showed how it might be obtained. Of all the elements known to the chemist up to the period of Wöhler's cessation from work it may be safely averred that there was not one but that had passed through his hands in some form or other. Now he was busy with chromium, then with cerium, next with uranium and the platinum metals; titanium, tantalum, thorium, thallium, tungsten,—all came in for some share of his attention, Of the minerals and meteorites he analysed the number is legion. Indeed, as Professor Hofmann says, whoever sent him a piece of meteoric iron gained his heart. His restless activity was a source of continual wonder to his friends. "How happy art thou in thy work!" wrote Liebig on one occasion. "Thou art like the man in the Indian fable, who, when he laughed, dropped roses from his mouth!"

The names of Liebig and Wöhler are now so closely intertwined in the history of chemistry that it is hardly possible to avoid comparing the men. Such a comparison has already been drawn by one who of all others is most fitted to draw it. "Liebig," says Dr. Hofmann, "fiery and impetuous, seizing a new thought with enthusiasm, and giving to it the reins of his fancy, tenacious of his convictions, but open to the recognition of error, sincerely grateful, indeed, when made conscious of it. Wöhler, calm and deliberate, entering upon a fresh problem after full reflection, guarding himself against each rash conclusion, and only after the most rigorous testing, by which every chance of error seemed to be excluded, giving expression to his opinion—but both following the path of enquiry in their several ways, and animated by the same intense love of truth! Liebig, irritable and quick to take offence, hot tempered, hardly master of his emotions, which not unfrequently found vent in bitter words, involving him in long and painful quarrels:—Wöhler, unimpassioned, meeting even the most malignant provocations with an immovable equanimity, disarming the bitterest opponent by the sobriety of his speech—a firm enemy to strife and contention—and yet both men penetrated by the same unswerving sense of rectitude! Can we marvel that between two such natures, so differently ordered and yet so complementary, there should ripen a friendship which both should reckon as the greatest gain of their lives?"

Who can fully gauge the influence of such a nature as Wöhler's? How it was exerted on Liebig is indicated in the following letter:—

"Gottingen, March 9, 1843.

"To make war against Marchand, or indeed against anybody else, brings no contentment with it, and is of little use to science. . . . . Imagine that it is the year 1900, when we are both dissolved into carbonic acid, water, and ammonia, and our ashes, it may be, are part of the bones of some dog which has despoiled our graves,—who cares then whether we have lived in peace or anger; who thinks then of thy polemics, of the sacrifice of thy health and rest for science? Nobody. But thy good ideas, the new facts which thou hast discovered,—these, sifted from all that is immaterial, will be known and remembered to all time. But how comes it that I should advise the lion to eat sugar!"

It was thus in philosophic contentment, happy in his work, happy in his home-life, happy in his friendships, that Wöhler lived out his four-score years and two. He made Göttingen famous as a school of chemistry: at the time of the one-and-twentieth year of his connection with the University it was found that upwards of 8000 students had listened to his lectures or worked in his laboratory.

He was a man whom the world has delighted to honour, and there was hardly an academy of science or a learned society which has not in some way or other recognised his services to science. Hs was made a Foreign Member of the Royal Society in 1854, a Corresponding Member of the Berlin Academy in 1855, Foreign Associate of the Institute of France in 1864, and in 1872 he received the Copley Medal from the Royal Society. On the 23rd of September, 1882,—

He gave his honours to the world again
His blessed part to Heaven, and slept in peace

A NEW METHOD FOR THE QUALITATIVE SEPARATION OF TIN, ANTIMONY, AND ARSENIC.

By EMIL BERGLUND.

The author remarks that the present methods for the separation of these metals are either inaccurate or tedious. He proposes a process based on the fact that the sulphides of the three metals when boiled with copper oxide in an alkaline solution are desulphurised and converted into oxygen compounds. The three elements are brought to their highest stage of oxidation, being transformed respectively into stannic, antimonic, and arsenic acids, whilst the copper forms not cuprous but cupric sulphide.

Copper oxide acts with especial ease upon the dissolved sulphur compounds, the denser varieties more slowly than the less compact, but as the latter give a very voluminous precipitate, the author prefers the former. He precipitates a solution of copper with sodium carbonate, and dries the oxide at 100° to 150°. By preference, however, he prepares his oxide from the nitrate as follows:—The solution of copper nitrate is evaporated to dryness in a small porcelain capsule, and heated to incipient decomposition. The mass is let cool, pulverised, and transferred to a porcelain capsule as small as possible, supported on a wire gauze, and heated, with constant stirring, until all the nitrate is decomposed. The heat must not be stronger

than is absolutely necessary. The oxide thus obtained is reduced to an impalpable powder.

This copper oxide is readily sulphurised, and yields a very dense precipitate, easy to filter. The sulphides of tin, antimony, and arsenic must be dissolved in sodium sulphide, not in the hydrate.

The procedure is as follows:—The sulphides, dissolved in the ordinary manner in ammonia, and precipitated by hydrochloric acid, are well washed, and rinsed from the filter into a porcelain capsule. The mixture is raised to a boil; sodium sulphide (avoiding large excess) is added cautiously, stirring constantly, and keeping up a gentle boil until a perfectly clear solution is obtained, or the analyst is convinced that any dark brown residue is merely copper sulphide which has been dissolved by the ammonium sulphide from the original precipitate given by sulphuretted hydrogen. Disregarding this copper sulphide, if present, copper oxide is added, and the stirring and ebullition are continued. It is easy to decide when the desulphurisation is complete; the copper oxide subsides as a very heavy powder, and the supernatant liquid becomes quite colourless, not yellow as previously. If this change does not occur in the course of two or three minutes, more copper oxide must be added, though it is preferable to take a sufficiency at first.

The liquid is filtered while still warm. In the filtrate tin, antimony, and arsenic exist as sodium stannate, antimoniate, and arseniate. If the proportion of antimony is considerable there is formed a white granular precipitate as the filtrate cools. When cold the filtrate is mixed with from a quarter to one-third its volume of alcohol, when the antimony separates out as an exceedingly fine white precipitate, and after standing for some time it is filtered off; if the filtrate is turbid, as is generally the case, it is repeatedly poured back upon the filter. The filtrate, when clear, is boiled to expel the alcohol, and mixed with an excess of ammonium chloride, which is added in a strong solution to prevent unnecessary dilution.

If a milky precipitate is formed on adding the sal-ammoniac, tin is present in the solution; but if no precipitate is formed, this metal exists in mere traces. If arsenic is present, it enters partially or entirely into the precipitate in the form of $2SnO_2As_2O_5$. Whether the sal-ammoniac produces a precipitate or not a few drops of ammonia is added, and a current of sulphuretted hydrogen is passed in. If no precipitate appears very little sulphuretted hydrogen is applied; otherwise this treatment is continued until the precipitate re-dissolves, leaving, possibly, some translucent flakes of silica and alumina. To the liquid, filtered if necessary, is added one-third of its volume of ammonia, and then magnesia mixture, when arsenic is deposited as a crystalline precipitate of ammonio-magnesium arseniate. If the presence of tin has not been distinctly proved, the arsenical precipitate is filtered off after the lapse of an hour, and the filtrate acidulated with hydrochloric acid. A yellow precipitate shows the presence of tin; in its absence there appears merely a slight white deposit of sulphur.

The above method for separating tin and arsenic is a modification of that of Lenssen. The authors purpose studying the applicability of his process to quantitative separations of the three metals.—*Berichte Deutsch. Chem. Gesellschaft.*

The Ptomaines: Chemical, Physiological, and Medico-Legal Investigations.—J. Guareschi and A. Mosso.—The authors examine the influence of the ptomaine hydrochlorate upon nerves and muscles by means of the graphic method. They next inquire into the mechanism of the action of curare, of the ptomaines, and of those poisons which act upon the nervous system. Further experiments were made on the extraction of alkaloids from brain, from the flesh of a calf with and without the use of acids. The method of Dragendorff is found unsatisfactory, and preference is given to that of Stas and Otto.—*Journ. fur Prakt. Chem.*, xxviii., 11.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B., Chief Chemist to the U.S. Geological Survey, Washington.

TUNGSTEN.

THE atomic weight of tungsten has been determined from analyses of the trioxide, the hexchloride, and the tungstates of iron, silver, and barium.

The composition of the trioxide has been the subject of many investigations. Malaguti† reduced this substance to the blue oxide, and from the difference between the weights of the two compounds obtained a result now known to be considerably too high. In general, however, the method of investigation has been to reduce WO_3 to W in a stream of hydrogen at a white heat, and afterwards to reoxidise the metal, thus getting from one sample of material two results for the percentage of tungsten. This method is unquestionably accurate, provided that the trioxide used be pure.

The first experiments which we need consider are, as usual, those of Berzelius.‡ 899 parts WO_3 gave, on reduction, 716 of metal. 676 of metal, reoxidised, gave 846 WO_3. Hence these percentages of W in WO_3:—

79·644 by reduction.
79·905 by oxidation.

Mean 79·7745 ± 0·0880

These figures are far too high, the error being undoubtedly due to the presence of alkaline impurity in the trioxide employed.

Next in order of time comes the work of Schneider,‖ who, with characteristic carefulness, took every precaution to get pure material. His percentages of tungsten are as follows:—

Reduction Series.

79·336
79·254
79·312
79·326
79·350

Mean 79·3156 ± 0·0112

Oxidation Series.

79·329
79·324
79·328

Mean 79·327 ± 0·0010

Closely agreeing with these figures are those of Marchand,§ published in the following year:—

Reduction Series.

79·307
79·302

Mean 72·3045 ± 0·0017

Oxidation Series.

79·321
79·352

Mean 79·3365 ± 0·0105

The figures obtained by v. Borch¶ agree in mean tolerably well with the foregoing. They are as follows:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Journ. f. Prakt. Chem*, 8, 179. 1836.
‡ *Poggend. Annal.*, 8, 1. 1826.
‖ *Journ. f. Prakt. Chem.*, 50, 152. 1850.
§ *Ann. Chem. Pharm.*, 77, 261. 1851.
¶ *Journ. f. Prakt. Chem.*, 54, 254. 1851.

Reduction Series.

79·310
79·212
79·289
79·313
79·225
79·290
79·302

Mean 79·277 ± 0·0106

Oxidation Series.

79·359
79·339

Mean 79·349 ± 0·0067

Dumas* gives only a reduction series, based upon trioxide obtained by the ignition of a pure ammonium tungsten. The reduction was effected in a porcelain boat, platinum being objectionable on account of the tendency of tungstate to alloy with it. Dumas publishes only weighings, from which I have calculated the percentages:—

2·784 grms.	WO_3 gave	2·208 grms. W.	79·310	per cent.
2·994	,,	2·373 ,,	79·259	,,
4·600	,,	3·649 ,,	79·326	,,
0·985	,,	0·781 ,,	79·289	,,
0·917	,,	0·727 ,,	79·280	,,
0·917	,,	0·728 ,,	79·389	,,
1·717	,,	1·362 ,,	79·324	,,
2·988	,,	2·370 ,,	79·317	,,

Mean 79·312 ± 0·009

The data furnished by Bernoulli† differ widely from those just given. This chemist undoubtedly worked with impure material, the trioxide having a greenish tinge. Hence the results are too high. These are the percentages of W:—

Reduction Series.

79·556
79·526
79·553
79·558
79·549
78·736

Mean 79·413 ± 0·091

Oxidation Series.

79·558
79·656
79·555
79·554

Mean 79·581 ± 0·017

Two reduction experiments by Persoz‡ give the following results:—

1·7999 grms.	WO_3 gave	1·4274 grms. W.	79·304	per cent.
2·249	,,	1·784 ,,	79·324	,,

Mean 79·314 ± 0·007

Finally we have the work done by Roscoe.‖ This chemist used a porcelain boat and tube, and made six weighings after successive reductions and oxidations, with the same sample of 7·884 grms. of trioxide. These weighings give me the following five percentages, which, for the sake of uniformity with foregoing series, I have classified under the usual separate headings:—

* *Ann. Chem. Pharm.*, 113, 23. 1860.
† *Poggend. Annal.*, 111, 573. 1860.
‡ *Zeit. Anal. Chem.*, 3, 260. 1864.
‖ *Ann. Chem. Pharm.*, 162, 368. 1872

Reduction Series.

79·196
79·285
79·308

Mean 79·263 ± 0·023

Oxidation Series.

79·230
79·299

Mean 79·2645 ± 0·0233

There are still other experiments by Riche*, which I have not been able to get in detail. They cannot be of any value, however, for they give to tungsten an atomic weight of about ten units too low. We may therefore neglect this series, and go on to combine the others:—

Berzelius	79·7745 ±	0·088
Schneider, Reduction	79·3156	0·0112
,, Oxidation	79·327	0·0010
Marchand, Reduction	79·3045	0·0017
,, Oxidation	79·3365	0·0105
v. Borch, Reduction	79·277	0·0106
,, Oxidation	79·349	0·0067
Dumas	79·312	0·009
Bernoulli, Reduction	79·413	0·091
,, Oxidation	79·581	0·017
Persoz	79·314	0·007
Roscoe, Reduction	79·263	0·023
,, Oxidation	79·2645	0·0233
General Mean ..	79·3215	0·00085

The rejection of the figures given by Berzelius and by Bernoulli exerts an important influence upon the final result. There is, therefore, no practical objection to retaining them in the discussion.

In 1861 Scheibler† deduced the atomic weight of tungsten from analyses of barium metatungstate, $BaO.4WO_3.9H_2O$. In four experiments he estimated the barium as sulphate, getting closely concordant results, which were, however, very far too low. These, therefore, are rejected. But from the percentage of water in the salt a very good result was attained. The percentages of water are as follows:—

13·053
13·054
13·045
13·010
13·022

Mean 13·0368 ± 0·0060

The work of Zettnow,‡ published in 1867, was somewhat more complicated than any of the foregoing researches. He prepared the pure tungstates of silver and of iron, and from their composition determined the atomic weight of tungsten.

In the case of the iron salt the method of working was this:—The pure, artificial $FeWO_4$ was fused with sodium carbonate, the resulting sodium tungstate was extracted by water, and the thoroughly washed, residual ferric oxide was dissolved in hydrochloric acid. This solution was then reduced by zinc, and titrated for iron with potassium permanganate. Corrections were applied for the drop in excess of permanganate needed to produce distinct reddening, and for the iron contained in the zinc. 11·956 grms. of the latter metal contained iron corresponding to 0·6 cc. of the standard solution. The permanganate was standardised by comparison with pure ammonium-ferrous sulphate, $Am_2Fe(SO_4)_2.6H_2O$, so that, in point of fact, Zettnow establishes directly only the ratio between that salt

* *Journ. f. Prakt. Chem.*, 69, 10. 1857.
† *Ibid*, 83, 324.
‡ *Poggend. Annal.*, 130, 30.

and the ferrous tungstate. From Zettnow's four experiments in standardising I find that 1 c.c. of his solution corresponds to 0·0365457 grms. of the double sulphate, with a probable error of ± 0·0000012.

Three sets of titrations were made. In the first a quantity of ferrous tungstate was treated according to the process given above; the iron solution was diluted to 500 c.c., and four titrations made upon 100 c.c. at a time. The second set was like the first, except that three titrations were made with 100 c.c. each, and a fourth upon 150 c.c. In the third set the iron solution was diluted to 300 c.c., and only two titrations upon 100 c.c. each were made. In sets one and two 30 grms. of zinc were used for the reduction of each, while in number three but 20 grms. were taken. Zettnow's figures, as given by him, are quite complicated; therefore I have reduced them to a common standard. After applying all corrections the following quantities of tungstate in grms. correspond to 1 c.c. of permanganate solution:—

$$\left.\begin{array}{l}0·028301\\0·028291\\0·028311\\0·028301\end{array}\right\}\text{First set.}$$

$$\left.\begin{array}{l}0·028367\\0·028368\\0·028367\\0·028367\end{array}\right\}\text{Second set.}$$

$$\left.\begin{array}{l}0·028438\\0·028438\end{array}\right\}\text{Third set.}$$

Mean 0·0283549 ± 0·0000115

With the silver tungstate, Ag_2WO_4, Zettnow employed two methods. In two experiments the substance was decomposed by nitric acid, and the silver thus taken into solution was titrated with standard sodium chloride. In three others the tungstate was treated directly with common salt, and the residual silver chloride collected and weighed. Here again, on account of some complexity in Zettnow's figures, I am compelled to reduce his data to a common standard. To 100 parts of AgCl the following quantities of Ag_2WO_4 correspond:—

By First Method.

161·665
161·603

Mean 161·634 ± 0·021

By Second Method.

161·687
161·651
161·613

Mean 161·650 ± 0·014

General mean from both series 161·645 ± 0·012

Finally, we have two analyses by Roscoe of tungsten hexchloride, published in the same paper with his results upon the trioxide. In one experiment the chlorine was determined as AgCl; in the other the chloride was reduced by hydrogen, and the residual tungsten estimated. By bringing both results into one form of expression we have for the percentage of chlorine in WCl_6:*—

53·588
53·632
53·610

Mean 53·610 ± 0·015

We have now five ratios from which to calculate the atomic weight of tungsten:—

(1.) Percentage of W in WO_3, 79·3215 ± 0·00085
(2.) Percentage of H_2O in $BaO.4WO_3.9H_2O$, 13·0368 ± 0·0060
(3.) $Am_2Fe(SO_4)_2.6H_2O : FeWO_4$ :: 0·0365457 ± 0·0000012 : 0·0283549 ± 0·0000115
(4.) $AgCl : Ag_2WO_4$ :: 100 : 161·645 ± 0·012
(5.) Percentage of Cl in WCl_6 53·610 ± 0·015

From these we get five values for tungsten, as follows:—

From (1)	W =	183·703	± 0·041
„ (2)	„	183·532	0·156
„ (3)	„	183·923	0·120
„ (4)	„	183·248	0·069
„ (5)	„	183·639	0·109
General mean	„	183·610	0·032
Or, if O = 16, then	„	184·032	

* The actual figures are as follows:—
19·5700 grms. WCl_6 gave 42·4127 grms. AgCl.
10·4326 „ 4·8374 „ tungsten.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 21, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:— H. Cave, F. W. Fleming, E. E. Graves, A. E. Lewis, S. Smith.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Drs. Wright and Hodgkinson, duly elected Fellows:—L. Archbutt, J. H. Burland, D. Bain, W. H. Barr, R. A. Bush, P. S. Chantrell, A. F. Damon, H. C. Draper, T. R. Duggan, V. Edwards, W. T. H. Elsley, G. W. Gibson, F. W. Harris, T. Hilditch, R. E. Moyle, P. Morton, W. J. Orsman, F. R. Power, A. E. Simpson, C. W. Sutton, H. G. Shaw, E. F. Smith, F. W. Tompson, A. Tarn, E. W. Voelcker.

It was announced that the following changes in the Vice-Presidents and Council were proposed:— Vice-Presidents—Dr. T. E. Thorpe and W. Weldon nominated instead of Dr. Crum Brown and Prof. Emerson Reynolds, who retire. Council—Drs. Carnelly and Messel, R. J. Friswell, and M. Carteighe nominated in place of Capt. Abney, Dr. Mills, Prof. McLeod, and G. H. Makins. Dr. Hodgkinson, Dr. Thorne, and F. W. Toms were appointed auditors.

The following paper was then read by Dr. GILBERT:— "*On the Composition of the Ash of Wheat Grain and Straw Grown at Rothamsted in Different Seasons and by Different Manures*," by Sir J. P. LAWES and Dr. J. H. GILBERT. This paper gives an account, including duplicates, of 253 analyses, most of which were made by R. Richter of Berlin. The ashes were prepared at Rothamsted, being burnt in oblong platinum dishes by surface heat, in order to prevent, as far as possible, any fusion. Every ash is of produce of known history of growth, as to soil, season, and manuring. The experiments are arranged in three series. The first illustrates the influence of fluctuation of season from year to year under three known but very different conditions as to manuring, during sixteen consecutive seasons. The second shows the influence of four characteristic seasons—two favourable and two unfavourable—under nine different conditions as to manuring. The third demonstrates the influence of continuous exhaustion or supply of certain constituents, as it represents the proportionally mixed produce for the ten years 1852-61, and the ten years 1862-71, from ten differently manured plots. In the first series the three plots were respectively (1) unmanured, (2) treated with 14 tons farmyard manure per acre, and (3) treated with

about 200 lbs. ammonium sulphate and 200 lbs. of ammonium chloride per acre annually. The principal points of interest in the analyses are the relative quantities of potash and phosphoric acid. The chief conclusions are that with normal maturation the grain is of nearly uniform composition whatever the manure, that the deviations from normal mineral composition are associated with deviations from normal development of the organic substance, and that the season has much more influence on the mineral composition of the grain than the manure. An obvious difference can nevertheless be detected in the average composition of the grain under the different conditions as to manuring: thus, the grain grown by ammonium salts alone shows exhaustion of potash, and especially of phosphoric acid. In the second series of analyses the following four seasons were selected:—1852, bad both as to quantity and quality of produce; 1856, quantity fair but quality indifferent; 1858, quantity moderate, quality above the average; 1863, good as to quantity and quality. As to manuring, the conditions were:—Unmanured; farmyard manure; ammonium salts alone; ammonium salts and superphosphate; ammonium salts, superphosphate, and soda salt; ammonium salts, superphosphate, and potash salt; ammonium salts, superphosphate, and magnesia salt; and finally a mixture of the last three. In the third series of analyses the manures employed were almost the same as those used in the second series, but the analyses relate to a period of twenty consecutive years. The results confirm those obtained in Series 1 and 2. It is seen that the amounts of mineral constituents taken up by the plant over a given area, depend very directly on the amounts in available condition within the soil, and that while the quantity stored in the grain is nearly uniform, the amounts remaining in the straw have a very obvious connection with the supply or exhaustion in the soil. The influence of season is also well marked. The composition of the grain, as to its mineral constituents, seems only to vary with the manure when there is a very abnormal deficiency of one or more constituents, having regard to the amount of growth which is induced by the liberal supply of others. The paper is very lengthy (over 70 pages), and contains eighteen tables of analyses. The authors promise in a future communication to give a similar series of analyses of ashes from barley, leguminous crops, root crops, potatoes, and the mixed herbage from grass land.

The PRESIDENT complimented Dr. Gilbert on the lucidity with which he had communicated the paper. It seemed to him a most interesting fact, brought out by this remarkable series of ash determinations, that the composition of the grain should be so uniform.

Mr. J. FARRINGTON gave an instance of the importance of the season with reference to the action of manures with potatoes. In a wet season the addition of kainit was without beneficial influence on the crop, but in a dry season its use was found to be very beneficial. He had also noticed that nitrates had at first more effect than ammonium salts in promoting growth.

Mr. LLOYD was much impressed with the fact that the mineral constituents in a poor crop were relatively larger than in a good crop. The roots probably gathered the mineral constituents independently of the season, and so if the weather was bad, and the organic constituents were not formed, the amount of mineral matter would be apparently increased. As the straw seemed to vary more or less with the manure applied, an analysis of the straw-ash might perhaps serve as an index of the mineral constituents wanting in the soil.

Dr. GILBERT said that at present it would be difficult to differentiate the mineral constituents of the straw-ash. There was no doubt that in bad seasons the maturation of the grain was sluggish and the starch formation imperfect, and so the percentage of mineral matter was raised.

"*On the Analysis of Shotley Bridge Spa Water*," by H. PEILE. Apparently only one analysis, and that incorrect, has been made of this water. The author has obtained the following numbers, indicating grammes per litre:—Barium chloride, 0·0569; ammonium chloride, 0·0042; calcium chloride, 0·2632; magnesium chloride, 0·0437; lithium chloride, 0·0565; potassium chloride, 0·0513; sodium chloride, 1·7333; calcium bicarbonate, 0·3964; ferrous bicarbonate, 0·0155; magnesium bromide, 0·0075; traces of magnesium bicarbonate and iodide, maganous bicarbonate, silica, phosphates, albumenoid ammonia. The water tastes strongly of iron.

The Society then adjourned to March 6th, when a paper by Drs. Armstrong and Miller, "On the Hydrolysis of Sulpho-Compounds," will be read.

NOTICES OF BOOKS.

The Art of Soap-Making. A Practical Handbook of the Manufacture of Hard and Soft Soaps, Toilet Soaps, &c. By ALEXANDER WATT. London: Crosby Lockwood and Co.

EVEN in these days of technological education a special treatise on soap-making has, prior to the issue of this work, been a desideratum in English literature. Dissertations on the subject have appeared from time to time in technical cyclopædias—we may mention those of Dr. Ure and of Messrs. Spon—and a variety of information may be found scattered through the scientific journals. But, with the exception of Morfit's important work, a special handbook of soap-making has been wanting. This has been a misfortune; not a few persons, well acquainted with the practice of the art, have remained unacquainted with its underlying principles, and have consequently been careless of, or even hostile to, improvement.

The work before us opens with a historical introduction, from which we learn some humiliating facts. Speaking of the introduction of a process for bleaching palm-oil the author says:—"When at last the trade were induced to give the process a trial, not unfrequently would the workmen put raw (that is unbleached) palm-oil into the batch which had been operated upon during the patentee's absence, so that their employers might denounce the demonstration as a failure." No improved patent-law can secure rapid industrial progress where employers and employed seem so obstinately averse to improvement.

We come next to the theory of saponification as based upon the researches of Chevreul and of Liebig.

In the second chapter we find a description of the plant of a soap-factory, the coppers, ley-tanks, frames, crutching tools, barring-apparatus, &c.

The materials used in soap-making are next considered. Here cotton-seed oil, an article coming more and more into use, is merely named, without any account of its properties.

Under "caustic soda" we read that the author, in conjunction with Mr. J. B. Spence, has devised and patented a process for obtaining caustic soda by the electrolysis of common salt. He hopes by this means to produce it at a great reduction in comparison with present prices. We need scarcely say that if no drawback turns up this will be a most important step. No mention is made of the fact that caustic potash is now made on the large scale in the solid state, so that the soap-boiler has now no occasion to be at the trouble of causticising common potash or pearl-ash.

The chapter on preparing the leys has lost much of its interest since caustic alkali became a common article of sale.

The manufacture of hard soaps is described very fully, in part according to Dussauce. In the instructions for making French mottled soaps taken from the latter author the alkali is directed to be obtained by causticising black-ash, which is also used in the London mottled soaps.

The old process of making hard soaps by saponification

with potash and subsequent conversion into a soda-soap, is described as being abandoned in England. It was an exceedingly wasteful procedure.

Resin soaps are next described as made in France. It is recommended to saponify the fatty matter and the resin separately, and to incorporate the two soaps by subsequent boiling. After treating of cocoa-nut oil, which requires a peculiar treatment, and gives, when used alone, a badly smelling soap, the author goes on to the "cold process," first devised by Mr. W. Hawes. The chief obstacle to the common adoption of this process has been the difficulty of obtaining ley of a sufficient strength, *i.e.*, 36° B., without previous evaporation. Now caustic soda is to be had in the solid state this objection falls away, and Mr. Watt thinks that the cold process might be fairly reconsidered.

Morfit's system of soap-making is next described. Its essential principle is the treatment of alkaline carbonates with fatty acids at a high temperature. The oleic acid from cotton-oil is especially recommended by the inventor.

A curious procedure was devised about a quarter of a century ago by Dr. Kottula. He adds to common soaps fatty matters, lime-liquor, sal-ammoniac, and alum. The author rightly calls in question the principle of this invention. Sal-ammoniac, boiled in lime-water, must be rapidly decomposed, whilst alum added to soda leys will yield sodium and aluminium sulphate.

The preparation of so-called silicated soaps, *i.e.*, soaps containing an admixture of silicate of soda, is next described. This addition was first suggested by Sheridan, but his methods were subsequently improved on by Gossage, of Widnes. The author, after describing the processes employed, remarks very justly that whenever soluble glass is employed the silica becomes separated out in washing, and leaves a deposit upon the articles washed. He might have added that textile fibres thus treated suffer abrasion, which in the case of wool and silk greatly injures their lustre. Some decided adulterants are next discussed, such as potato-farina and China-clay.

A much more interesting chapter is that devoted to saponification under pressure. We next come back to more sophistications, some of them of a disgusting nature. Thus four patents have been taken out, all by Frenchmen, for soaps containing slaughter-house offal. It scarcely need be said that nitrogenous animal matter inevitably putrefies in contact with alkalies. The changes produced will vary greatly according to the circumstances, and under conditions easily conceivable injury to health may ensue.

The composition of the soaps suitable for clearing madder-purples, and reds, and for ungumming silks, is given somewhat strangely among the soft soaps. A. M. Loch gives a formula for soft soaps into which sal-ammoniac and potassium dinoxalate as well as turpentine and Irish moss are to be introduced.

Toilet soaps, hard, soft, and liquid, are described at great length. Some of the receipts here given are quite practicable upon the small scale, and may prove very useful to chemists and druggists, perfumers, &c.

The twenty-third chapter gives an account of many miscellaneous processes, some of which, as the author intimates, bear the brand of absurdity very plainly. It is, indeed, curious to note what unlikely and unsuitable substances patentees have proposed to introduce into soaps. We have already had occasion to mention sal-ammoniac and alum; but we read now of saw-dust, chlorate of potash, "or any other substance which in process of solution in water will give off oxygen," "anthracine salt," gluten, liquid ammonia, steatite, tar, &c.

We have next instructions for alkalimetry and for the analysis of soaps. It is recommended, in order to determine the insoluble impurities in soap, to dissolve 100 grains of the sample in alcohol. This process will detect most of the substances used as adulterants. But it is unfortunately added in a foot-note that "good methylated spirit answers equally well, and is much cheaper than alcohol." But, except to large consumers who can find heavy security, it is not easy to obtain methylated spirit free from shellac. Darcet's method for determining the fatty acids by the acid of pure white wax is here given, and is very satisfactory.

After giving an account of the processes for bleaching oils, and for recovering glycerin from spent lyes, we find a chapter on "Miscellaneous Soaps," which seems here somewhat out of place, and might very fitly have been incorporated with earlier sections of the work. It contains directions for making soaps for the woollen trade, taken from a work by Philip Kürten written in very bad English. The author points out the error committed by Kürten in recommending soda-soaps for such purposes.

We consider that this work will prove very useful, not merely to the technological student, but to the practical soap-boiler, who wishes to understand the theory of his art and to become acquainted with the procedures followed in different countries as well as with the various proposals for improvement.

In case of a second edition. we may suggest that a bibliography of works, memoirs, &c., bearing on the subject would prove a useful appendix.

CORRESPONDENCE.

ZINC IN DRINKING WATER.

To the Editor of the Chemical News.

Sir,—After perusal of Mr. C. W. Heaton's note on the water at Cwmfelin contained in the Chemical News, vol. xlix., p. 85, the following, taken from an old laboratory note-book, may be of interest:—

Engaged to report on mineral properties in the Mendips in 1875 I had only an extemporised accommodation for making approximate analyses. I employed a soft rain-water from a cistern attached to the house, and stored this water in galvanised iron buckets. During an absence of three weeks, about two litres of this soft rain-water had been allowed to remain in such a galvanised iron bucket, and on my return attracted my attention by containing an abundant white flocculent precipitate. Collected and dried at 100° C., I obtained 3·25 grms. of an oxidised product of zinc, but unfortunately I did not carry the investigation further, neither as regards any peculiar properties of the water employed, nor the exact composition of this zinc salt.—I am, &c.,

J. Lainson Wills.

Caylus, Tarn et Garonne, France.
Feb. 25, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 11.

The Percentage of Alcohol and Extract in the Wines of Anjou.—A. Bouchard.—Analyses of wines from the vineyards of the Layon and the Loire.

Influence of Temperature upon the Fermentation of Must.—Dr. H. Müller.—The fermentation is completed the more rapidly the higher the temperature, whether the must is rich or poor in sugar. The fermentation is most violent at 27°. By using a high temperature it is possible to conduct the fermentation in such a manner that from musts containing a high proportion of

sugar wines may be obtained relatively low in alcohol, but still sweet, and incapable of further fermentation.

Vol. xiii., Part 1.

Pollution of the Water of Great Rivers by Town Sewage and the Self-purification of Rivers.—Dr. Franz Hulwa.—The author has examined the water of the Oder above Breslau, including the point where the supply for the town is pumped up, in its course through the town, below the sewage outfall, and at the distance of 14 kilos. lower down. He considers that a good water should contain in 100,000 parts not more than 50 parts total residue, 1·5 of nitric acid, and 3 parts chlorine, and mere traces of ammonia, albumenoid ammonia, and nitrous acid. For oxidation it should not require more than 0·25 part oxygen. From Ohlau down to a little above Breslau the water undergoes a slight but appreciable deterioration, yet after filtration it is quite suitable for domestic uses. In passing through the city there is a continuous change for the worse, manifested by the increase of oxidisable matter, and by the higher proportion of ammonia and nitric and nitrous acids. Below the sewer outfalls the water is exceedingly impure; there is an increase of total solids, of oxidisable matter, and of chlorine, whilst the ammonia and albumenoid ammonia are augmented a hundredfold. Microscopic examination detected the abundant presence of organisms of putrefaction. Further down was observed a gradual process of self-purification by contact with atmospheric oxygen along with the co-operation of vegetable and animal life in the stream. 14 kilos. below Breslau the influence of the sewage could no longer be detected either chemically or microscopically, the water being of the same composition as at the supply station above the city.

The Morphology and Chemistry of Natural and Artificial Ulmic Compounds.—Dr. J. J. Früh.—The author recognises two forms of peat, the granular and the homogeneous. The humoid bodies separated from peat are distinguished from those artificially obtained by the presence of nitrogen and their greater solubility in alcohol and water.

The Formation of Fat from Carbohydrates in the Animal Body.—N. Tschirwinsky, E. Meissl, and F. Strohmer.—The authors prove experimentally that the quantity of fat formed from carbohydrates is seven to eight times greater than that introduced into the system as such, or formed from the decomposition of albumenoids.

A Physical Property of Milk.—G. Recknagel.—The author has examined the thickening which takes place in milk after it has been drawn from the udder, irrespective of changes of temperature. If the freshly-drawn milk is kept at a temperature of about 15° the process of condensation is continued for two days at a decreasing rate, and extends to 0·8° to 1·5° of Quevenne's scale. The richer the milk the greater is the change. It is accelerated by a lower temperature, and at 5° is complete in six hours. The author ascribes this change to a swelling of the caseine.

Experiments on Digestive Processes in the Stomach and Bowel.—M. Ogata, Dr. Edinger, Dr. Falk, and others.—Digestion and the resorption of albumen given in the form of meat is not affected by the absence of bile. The resorption of carbohydrates given in the form of glucose or bread is likewise not interfered with. On the other hand the resorption of fat is greatly compromised. The bile does not appear to possess any antiseptic property. Its composition is not directly or essentially affected by the food. The quantity of the dry matter in the bile depends on the reception of food.

The Exciting Effects of Oats.—M. Sanson.—From the *Comptes Rendus*.

Observations on Various Diseases of Animals.—MM. Rotoff, Gibeir, and Israel.—This memoir possesses no chemical interest.

The Nutritive Value of Dried Diffusion Residues—Prof. Maercker.—Not adapted for abstraction.

The Nature and Action of the Poison of Lupins.—Dr. Arnold and Dr. Schneidemuhl.—The name lupinotoxine is proposed for this poisonous principle. It proves fatal to dogs in doses of from 2 to 5 grms.

Experiments on the Cultivation and Manuring of Different Kinds of Beets.—Prof. A. Nowoczek.—The author concludes that different soils and climates require different varieties of beet to yield a maximum crop. Knauer's electoral is mentioned as giving the highest proportion of sugar (betose).

The Action of Light on the Evolution of Oxygen in Plants.—J. Reinke.—A summary of the results obtained by Pringsheim.

Crystalline Secondary Pigments accompanying Chlorophyll.—J. Borodin.—A micro-chemical study of the dark green, yellow, red, and violet crystals obtained from extracts of plants in alcohol or benzin.

The Withering of Blossoms and Leaf-shoots.—Julius Wiesner.—Not adapted for abstraction.

Behaviour of the readily Oxidisable Constituents of the Sap of Plants.—C. Kraus.—The facts observed point to the existence of a chromogen, which is converted into a colouring-matter by oxidation within the cells.

Lime and Magnesia in Plants.—Dr. E. von Raumer.—According to the author's observations the function of lime is the production from the available plant-food of structural materials, especially for increasing and strengthening the cell-walls. The function of magnesia consists in the transmission of starch and in the formation of chlorophyll.

Importance of the Capture of Insects for Drosera rotundifolia.—Dr. H. Busgen.—A biological paper.

Phylloxera vastatrix and its Destruction.—A summary of the results obtained with various methods proposed for the destruction of this parasite.

Bulletin de la Société Chimique de Paris.
Vol. xli., No. 2, January 20, 1884.

This issue consists entirely of extracts from other journals.

No. 3, February 5, 1884.

Experiments on the Combustion of the Diamond.—C. Friedel.—The author's results agree entirely with those formerly obtained by MM. Dumas and Stas, as well as with the more recent determinations of MM. Roscoe and Schützenberger.

A Reply to the Reclamations of Priority of MM. Vincent and Delachanal.—F. Sestini.—The author refers to his memoir on the formation of the sulphocarbonates published in 1871, ten years before the date of their patent.

Sophistication of Tartar Emetic.—J. Casthelaz.—The substance of this communication has been already inserted.

Formation of Acetylene at the Expense of Iodoform.—P. Cazeneuve.—Powder of silver and of iodoform intimately mixed and moistened with a little water evolves acetylene, even in the cold. All metals having an affinity for iodine give an analogous reaction and produce metallic iodides.

Neutralisation-heat of Hydrofluoric Acid with the Alkaline and Earthy-alkaline Bases.—M. Guntz.—The value found for ammonia is +15·2 cals.; that of baryta, +17·4 cals.; strontia, +17·9 cals.; and lime, +18·6 cals.

Development of a Schistous Structure in Compressed Bodies.—Ed. Jannettaz.—A schistous structure has been produced by pressure in clay, graphite, talc, steatite, and in various metals.

NOTES AND QUERIES.

Oxygen.—Could any of your readers kindly tell me the best plan of making oxygen on the large scale by either Mallet, Maréchal, or Tessié du Motay's process, and if the latter method is patented or not? If they are worked in England, where?—T. F. C.

Hyposulphate of Soda: Oxysulphate of Lead.—Can any of your readers inform me where hyposul*phate* (not phite) of soda is manufactured? Also where the basic or oxysulphate of lead is manufactured? and the prices of these two substances, viz, lead and hyposulphate of soda?—J. H. R.

MEETINGS FOR THE WEEK

Saturday, Mar. 1.—Royal Medical and Chirurgical, 8. (Anniversary.)
Monday, Mar. 3rd.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "Building of London Houses," by Robert W. Edis, F.S.A.
— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie. General Monthly Meeting, 5 p.m.
Society of Chemical Industry, 8 p.m. "On the Manufacture of Cuprammonium and Zinc-ammonium, and their Uses." "On the Filtration of Potable Waters." "On some Applications of Keiselghur."
Tuesday, 4th.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
Wednesday, 5th.—Society of Arts, 8. "The Progress of Electric Lighting," by W. H. Preece, F.R.S.
— Geological, 8.
— Pharmaceutical, 8.
Thursday, 6th.—Royal, 4.30.
— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
— London Institution, 7.
— Chemical, 8. "Studies on Sulphonic Acids. No. 1. On the Hydrolysis of Sulpho-compounds, and on the Recovery of the Benzines from their Sulphonic Acid," by Dr. Armstrong and Dr. Miller. "Note on the Behaviour of the Nitrogen of Coal during Destructive Distillation, and a comparison of the Amount of Nitrogen left in Coke of various origin," by Watson Smith. "Note on some Experiments to Determine the Value of Ensilage as a Milk- and Butter-producing Food," by T. Farrington, M.A.
Friday, 7th.—Royal Institution, 8. "Bicycles and Tricycles," by Mr. C. V. Boys, at 9.
— Society of Arts, 8. "The New Bengal Rent Bill," by W. Seton-Karr.
Saturday, 8.—Royal Institution, 3. "Photographic Action," by Capt. Abney.
— Physical, 3. "Experiments illustrating an Explanation of Hall's Phenomena," by Mr. Shelford Bidwell. "Note on Hall's Phenomena," by Prof. S. P. Thompson, D.Sc., and Mr. Colman C. Starling.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1267.

ACTION OF WATER ON ZINC: EFFECTS OF DRINKING-WATER CONTAMINATED WITH ZINC.*

By THOMAS STEVENSON, M.D.

The experiments of Boutigny, Schaueffele, and Langonné have long since shown us that zinc dissolves in potable waters at ordinary temperatures; that distilled water and rain-water dissolve zinc more readily than hard waters, especially those that are rich in chalk. They have shown, however, that hard potable waters do not take up zinc to an appreciable extent, for the zinc speedily becomes coated with an insoluble layer of zinc hydrate (hydrated oxide), or, more commonly, of hydrocarbonate (hydrated oxide and carbonate); but still a portion of the metal remains suspended, whilst a smaller portion, perhaps, passes into a state of true solution. Thus, all kinds of vessels in domestic use, whether made of zinc or "galvanised," impart to waters kept in, or allowed to pass through them, a certain quantity of zinc. The quantity of zinc thus taken up may even be sufficient to render the water opalescent, and unfit for drinking purposes.

Fonssagrives,† taking up the question of the nocuity or innocuity of waters kept in zinc vessels, or in those which are galvanised (*i.e.*, coated with zinc), investigated it by the data furnished by records of the public health, by the experience of naval hygiene, and by experiments on man and upon animals. He does not, however, adduce any experiments of his own. A French Government Commission had previously, on what appeared to Fonssagrives insufficient grounds, decided that water kept in vessels of zinc is injurious to health. Boutigny had likewise attributed very grave effects to the use of waters thus stored, and even imagined that epilepsy might be produced by the ingestion of zinc oxide. Fonssagrives concluded, as the result of his investigations, that the insoluble preparations of zinc produce no digestive disturbances except when taken in large doses, and that they do not accumulate in the economy. He admits that water in contact with metallic zinc becomes coated with zinc compounds, but that these—zinc hydrate, hydrocarbonate, and ulmate—are almost insoluble. Rain-water passing over the metal may, nevertheless, remove some zinc in solution, as zincate of ammonia. These compounds, he states, exist in waters in such small quantities that no injurious effects can, in his opinion, result from their use. He adds that the facts drawn from toxicology, naval hygiene, public hygiene, and therapeutics, all attest the innocuity of water that has rested upon zinc. In consequence, the use of zinc and galvanised iron cisterns, of zinc pipes, and of galvanised iron pipes, for the conveyance of water, cannot be considered dangerous to health.

Others, nevertheless, hold a different opinion. Pappenheim‡ states that, though the amount of zinc present in such waters as have been spoken of is not always sufficient to produce poisonous effects, since it is indubitable that they have frequently been employed for considerable lengths of time with impunity, yet the amount of metal taken up by large quantities of water may be sufficient to produce deleterious results. He states, moreover, that in France, spite of Fonssagrives's assertions, the water tanks of ships have had to be re-galvanised and tinned, and that zinc vessels have to be especially avoided. Dr. Parkes likewise states* that Dr. Osborne, of Bitterne, has frequently observed injurious effects from the use of waters impregnated with zinc.

* Reprinted from "Guy's Hospital Reports" [3rd Series], vol. xvii. p. 233, 1872.
† *Annals d'Hygiene*, t. xxi., p. 64.
‡ *Handb. d. Sanitätspolizei*, b. ii., p. 765.

Of the fact that water does, under certain conditions, act energetically upon zinc and upon galvanised iron, I have had abundant evidence. Some months ago I was consulted by a gentleman relative to the water-supply to his house. The existing supply, from a well on the premises, furnished an excessively hard, chalky, and seleniferous water. It being desirable, for many reasons, to have a soft water, I advised that the rain-water from the extensive slate-covered premises should be filtered and stored for use, as the house was remote from possible sources of contamination of the rain-water. As a matter of precaution, I recommended the use of iron pipes for conveying the water, and that, after filtration through charcoal, sand, and gravel, the water should be stored in a tank lined with asphalt. Against my knowledge, galvanised iron pipes were used instead of those of iron only. The consequence of this has been that the water passing from the reservoir through the galvanised pipes has for many weeks been turbid and milky in appearance. It contains a notable quantity of zinc in suspension, and some in solution. I may remark that zinc in solution in potable waters is best detected by the addition of potassic ferrocyanide to the clear water after acidulation with hydrochloric acid, when a whitish cloud will immediately form if zinc be present. Of course this reaction must be confirmed by other and well-known tests. I know of no test for zinc which is so delicate as this.

What might be the effect of drinking such water as I have described I cannot say, for no one would touch it if other water were to be obtained. Probably, its continued use might be productive of injurious effects.

Engineers should bear in mind this effect of *rain-water* upon zinc and upon the so-called galvanised iron.

NOTES ON A RECENT DISCOVERY OF A PARAFFIN SHALE DEPOSIT IN SERVIA.

By A. B. GRIFFITHS, Ph.D., F.C.S. (London and Paris). Medallist in Chemistry and Botany, &c.

These deposits are situated near the River Golabara in the west part of Servia. The shale occurs in upheaved cliffs about 200 feet above the surrounding plains. The formation consists, according to the geologists, engineers, &c., who have inspected it, of hundreds of layers of white and gray shale, one above the other, sometimes being separated by small beds of clay of a whitish colour, containing rock-salt (or "beds of fossil salt" as Lyell liked to call it), and sodium and magnesium sulphides. The extent of this geological formation is very great, extending, as at present discovered, unbroken, over 30 square miles of country. The layers of shale are foliated almost like sheets of paper, this being due, it is said, to the great pressure they have been subjected to during their formation or subsequent. I am given to understand that the whole territory in this part of the country strongly resembles the paraffin and salts districts of Galicia. These Servian deposits are rich in paraffin, and have remained unobserved until about a year ago; but it has been known for ages that cattle, birds, and other animals have been in the habit of resorting to these cliffs and eating the clay containing the rock-salt.

This paraffin shale is entirely free from bituminous impurities, and is of a nearly white colour; it has no odour.

When this shale is heated to about 800° F. (426° C.) it takes fire and burns with a clear bright and smokeless flame, leaving a gray ash behind.

It is very difficult to say what is the origin of the paraffin in these deposits, but most likely it is of vegetable origin,

* "Manual of Hygiene," 3rd edit., p. 12.

having been produced from the distillation of the old brown coals which abound in the vicinity of the deposits.

Eruptive porphyry and trachytic rocks are plentiful at a distance of five or six miles. The deposits of paraffin shale are of marine origin and of the Eocene period. The eruptive rocks just alluded to protrude into these deposits and are of a later date than the deposits themselves. In the clay beds (which is peculiarly free from ferric oxide) large numbers of the genera Ostrea, Cerithium, Cyrena, Nautilus, Pleurotoma, Voluta, Cancellaria, &c., with the fossil remains of various sea-fish belonging to this geological age are to be found. The clays of this area, from which the shales were originally formed, contain innumerable microscopic siliceous shells of marine Diatomaceæ, with the calcareous shells of Foraminifera (principally of the genus Nummulites), and it is supposed to be similar to the ooze now forming at the bottom of the Atlantic and other oceans. It is thought that in the limestone rocks which underlie these shale deposits, rock-salt and petroleum wells will be found. I may say that it is highly probable that all the deposits of the neighbourhood are more or less of organic origin (limestones, shales, brown-coal, paraffin, &c.), or as the poet Byron says—

"The dust we tread upon was once alive.

A sample of this paraffin shale yielded on distillation 2 per cent of a semi-solid hydrocarbon, somewhat similar in appearance to ozokerite wax, which on extracting with "benzoline" gave 1·75 per cent of wax. It also contains 3·02 per cent of water of combination, and 1·18 per cent of ammonia. The remaining ingredients being mineral constituents.

It is stated that the mineral constituents of this paraffin shale deposit would make a useful hydraulic cement. The shale could be extracted by open quarrying "at the cost of a few pence per ton."

Further, the engineers who have inspected the district, say that in distilling the shale on the spot, now that gas-retorts are in use, the shale itself can be utilised as fuel. The formation is so situated that it is in easy access of the Rivers Sawa and Danube. These notes may be of some use to the readers of this journal, for the geology, &c., of this part of Europe is little known.

ON A NEW FORM OF GAS ASSAY FURNACE.

By WALTER LEE BROWN.

In the Chemical News, vol. xlviii., p. 7, in the course of an article entitled "A New Volumetric Method for Estimating Arsenic," Prof. Leroy W. McCay makes the following statement concerning the determination of the silver in the arseniate by cupellation:—"This will do very well for large works like the Freiberger-Hütten, where muffles are running day and night, but in establishments not provided with furnaces of this kind, or in laboratories provided with them but only capable of firing up at certain seasons, the impossibility of a general and constant applicability of the process is at once evident."

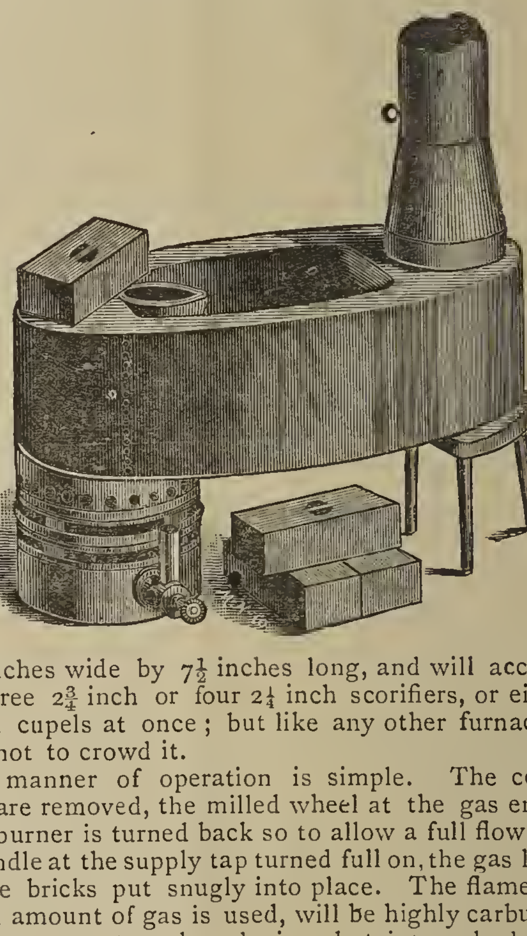
I have quoted the above in full because it embodies in plain language the same complaint which has many times been brought to my notice. My sole comment upon it is to advise Prof. McCay and any others to read my description of the simple but satisfactory little furnace represented here.

Let me first state that it is not my intention to claim originality as regards this furnace, but merely applicability and decided improvements in the form. It was Mr. Thomas Fletcher, of Warrington, England, to whom we are indebted for so many ingenious forms of apparatus for the utilisation of illuminating gas as a medium of heat, who devised the original furnace which I employed successfully in assaying for a year and a half. Its chief fault lay in the fact that but one scorifier or cupel could be operated at a time. This furnace had almost entirely escaped attention as an assay furnace, owing to its having been advertised mainly for melting small quantities of lead, copper, brass, &c., and in fact had been withdrawn from the market when I took hold of it.

With the idea of improving it so that it should be able to treat three or four or more scorifiers or cupels at once, and so be of great benefit to those desiring a furnace for small runnings, the present furnace was finally constructed.

As shown, the form is almost that of the reverberatory furnace, the movable bricks when in place forming the roof. From another point of view, it may be described as the muffle of an ordinary furnace, but having the flame as well as the heat inside. The exterior dimensions are as follows:—20 inches long, 7 inches wide, and $5\frac{1}{2}$ inches deep. The nozzle at the burner is connected with a $\frac{3}{8}$ inch tap by means of a full $\frac{1}{2}$ inch rubber tube. A 3-inch stove-pipe, *tightly fitting*, is connected with a flue.

In the interior, upon the floor, rest four little wedge-shaped pieces of fire-clay which are movable, and upon them rests a false floor, also movable. The latter (not shown in the cut), corresponds to the muffle bottom of an ordinary furnace, and upon it is done all the work. It



is $3\frac{1}{2}$ inches wide by $7\frac{1}{2}$ inches long, and will accommodate three $2\frac{3}{4}$ inch or four $2\frac{1}{4}$ inch scorifiers, or eighteen $1\frac{1}{4}$ inch cupels at once; but like any other furnace, it is better not to crowd it.

The manner of operation is simple. The covering bricks are removed, the milled wheel at the gas entrance to the burner is turned back so to allow a full flow of gas, the handle at the supply tap turned full on, the gas lighted, and the bricks put snugly into place. The flame, when the full amount of gas is used, will be highly carburetted, and of course strongly reducing, but intensely hot. In from fifteen to twenty minutes the interior will be hot enough for work. The bricks are removed, the charged scorifiers placed within, the bricks set back, the excess of gas turned off at the milled wheel, and the furnace kept closed till the charges are melted. After this has been effected, the bricks are separated or slid aside more or less to admit of air for scorification. Proper regulation is made by the milled wheel, by which the gas may be turned partially off as required, always leaving the supply tap fully open. The action of the air is also controlled by the damper in the pipe leading to the chimney.

To cupel, the gas supply is turned down more than in scorifying. The time of performing either scorification or cupellation varies according to the nature of the ore and other circumstances, but is about the same as in the use of a coke furnace.

This furnace does well for small crucible fusions, by removing the false floor and its supports.

The advantages of this furnace are many; convenience of operating whereby the assayer sees every step and stage of the operation, and so can tell when and where to change or improve; perfect control of the source of heat, so that a higher or lower temperature, a reducing or oxidising effect may be produced in an instant; entire noiselessness, in which characteristics it is the superior of all blast assay furnaces; saving of time, which in furnaces employing coke, charcoal, or coal is spent in "bedding down," feeding, &c; freedom from the annoyances of dust and ashes; absence of waste, for when the work is performed the gas is at once shut off; comfort in manipulation, for it does not heat up a room as do most furnaces (quite a desideratum in the summer time); finally, its remaining qualifications, which need not be dwelt upon, are simplicity of construction, durability, and portability.

The consumption of gas is not far from 30 cubic feet per hour. It is not intended nor claimed that this furnace can take the place of one required to be run from ten to twelve hours per day, for here, of course, a solid fuel will be cheaper, but for small runnings of from one to three hours or so it is economical with gas as high as 3 dols. per thousand, and much more so when the latter is as cheap as it is in England.

The few furnace tools required can easily be made from quarter-inch wire.

The furnace sells for 20 dols., and is made by the Buffalo Dental Manufacturing Co., of Buffalo, N.Y. I can only say further that the furnace is really a beautiful piece of work and delights everyone who sees it in operation.

Chicago, Ill., January 31, 1884.

ON ELECTROLYSIS.

By H. SCHUCHT.

CONCERNING the separations which take place at the positive pole, the composition of the peroxides and the manner of their determination, relatively little has been done.

If solutions of the salts of lead, thallium, silver, bismuth, nickel, and cobalt, are decomposed by the current between platinum electrodes, metal is deposited at the negative, and oxide at the positive electrode. Manganese is precipitated only as peroxide. The formation of peroxide is, of course, effected by the ozone found in the electrolytic oxygen at the positive pole; the oxide existing in solution is brought to a higher degree of oxidation and is separated out. Its formation may be decreased or entirely prevented by the addition of readily oxidisable bodies, such as organic acids, lactose, glycerin, and preferably by an excess of oxalic acid; but only until the organic matter is transformed into carbonic acid. In this manner Classen separates other metals from manganese in order to prevent the saline solutions from being retained by the peroxide.

With solutions of silver, bismuth, nickel, and cobalt, it is often practicable to prevent the separation of oxide by giving the current a greater resistance—increasing the distance between the electrodes.

The proportion between the quantities of metal and of peroxide deposited is not constant, and even if we disregard the concentration of the solution, the strength of the current and secondary influences (action of nascent hydrogen) is different in acid and in alkaline solutions. In acid solutions much peroxide is formed; in alkaline liquids, little or none. The reason of the difference is that ozone is evolved principally in acid solutions, but appears in small quantities only in alkaline liquids, or under certain circumstances not at all. The quantity of peroxide deposited depends also on the temperature of the saline solution; at ordinary temperatures the author obtained more peroxide—the solution, the time, and the strength of current being equal—than from a heated liquid. The cause is that ozone is destroyed by heat and converted into ordinary oxygen. With the exception of lead and thallium the quantity of metal deposited from an acid solution is always greater than that of the peroxide.

Lead.—Luckow has shown that from acid solutions—no matter what may be the acid—lead is deposited at the anode as a mixture of anhydrous and hydrated peroxide of variable composition. Only very strongly acid solutions let all their lead fall down as peroxide; the precipitation is rapid immediately on closing the circuit, and complete separation is effected only in presence of at least 10 per cent of free nitric acid. As the current becomes stronger with the increase of free acid there is deposited upon the first compact layer a new stratum of loosely adhering peroxide.

In presence of small quantities of other metals which are thrown down by the current in the metallic state, such as copper, mercury, &c., peroxide alone is deposited from a solution of lead containing small quantities only of free nitric acid.

The lead peroxide deposited is at first light brown or dark red, and becomes constantly darker and finally taking a velvet-black. As its stratification upon the platinum is unequal it forms beautifully coloured rings.

Experiments show that the quantity of peroxide deposited depends on the nature of the solution and the strength of the current. In case of very feeble currents and slight acidity, its quantity is so small that it does not need to be taken into consideration. If the lead solution is very dilute scarcely any current is observed, lead solutions *per se* being very bad conductors of electricity.

Faintly acid concentrated lead solutions give loose peroxide along with much spongy metallic lead. Free alkali decreases the separation of peroxide; feebly alkaline solutions, concentrated and dilute, yield relatively much peroxide along with metallic lead, whilst strongly alkaline solutions deposit no peroxide.

Dried lead peroxide is so sparingly hygroscopic that it may be weighed as such; its weight remains constant upon the balance for a long time. In order to apply the peroxide for quantitative determinations a large surface must be exposed to action. As positive electrode a platinum capsule is convenient and a platinum disc as negative pole. The capsule shape is necessary because the peroxide when deposited in large quantities adheres only partially, and falls in part in thin loose scales. It is necessary to syphon off the nitric solution, since, like all peroxides, that of lead is not absolutely insoluble in nitric acid. The methods of Riche and May give results which are always too high, since portions of saline solution are retained by the spongy deposit and can be but very imperfectly removed by washing. This is especially the case in presence of free alkali.

The author has proceeded as follows:—The lead peroxide is dried in the capsule and there is passed over it pure dry gaseous sulphurous acid in a strong current from a rather narrow delivery tube. Lead sulphate is formed with evolution of heat; it is let cool under the exsiccator and weighed as such. Or he ignites the peroxide along with finely pulverised ammonium sulphite; the mass must have a pure white colour. After the conclusion of the reaction it is ignited for about 20 minutes. The results are too high. The proportion of actual lead peroxide in the deposit ranges from 94 to 94·76 per cent. The peroxide precipitated from a nitric solution may, under certain circumstances, be anhydrous. This result is due to the secondary influences at the positive pole where the free acid gradually withdraws water from the peroxide.

The peroxide thrown down from alkaline solutions retains alkali so obstinately that it cannot be removed by washing; the peroxide plays here the part of an acid. The lead nitrate mechanically inclosed in the peroxide is resolved by ignition into oxide, hyponitric acid, and oxygen; this small proportion of lead oxide does not exert an important influence on the final result. The quantity of matter mechanically inclosed is relatively high, as in the precipitation of much lead peroxide there is relatively more

saline matter occluded than when a few centigrammes are deposited. The peroxide incloses also more foreign matter if it is thrown down upon a small surface than if it s deposited in a thin layer over a broad surface. From numerous analyses the auther concludes that in presence of much free nitric acid the proportion of water is increased; with free alkali the reverse holds good.

Thallium behaves similarly to lead. From a nitric acid solution it is thrown down, according to the proportion of free acid, either as sesquioxide only or in small quantities as silvery, metallic leaflets; from alkaline solutions it is deposited as sesquioxide and metal, the latter of a lead-grey colour. Thallium solutions conduct the electric current badly. Thallium oxide resembles lead peroxide in colour; at a strong heat it melts, becomes darker, and is converted into peroxide, in which state it can be weighed.

Silver.—All solutions of silver salts, except the nitrate, and those containing a very large quantity of free nitric acid or nitrates, deposit electrolytically merely metallic silver. In the above-mentioned exceptional cases there is formed a small quantity of peroxide which adheres to the anode as a blackish grey deposit. The greatest quantity of peroxide is obtained on employing a concentrated, strongly acid solution of the nitrate, and a strong current. If the solution is very dilute we obtain no peroxide, or mere traces which disappear again towards the end of the process. The peroxide is deposited at first in small, dark, shining octahedral crystals; subsequently, in an amorphous state. At 110° it evolves oxygen suddenly and is converted into metallic silver. It dissolves in ammonia with a violent escape of nitrogen. In nitric acid it dissolves without decomposition and with a red colour.

The author uses a galvanic current for reducing silver-residues, consisting of sulphocyanide. The salt is mixed with sulphuric acid in a roomy platinum capsule, and a fine platinum wire gauze is used as positive electrode.

Bismuth.—The current resolves bismuth solutions into metal and bismuthic acid. The latter is deposited at the positive pole, and in thin layers appears of a golden-yellow, but in thick strata is darker, approaching to red. Its formation is very gradual, and in time it disappears again, owing to secondary actions of the current. On ignition it becomes lemon-yellow, and transitorily darker, even brown, and passes into the sesquioxide.

Nickel and Cobalt.—On the electrolysis of the ammoniacal solution the sesquioxide appears at the positive pole. Its formation is prevented by an excess of ammonia. The auther never obtained more than 3½ per cent of the quantity of the metal. The sesquioxides dissolve in ammonia without escape of nitrogen and are usually anhydrous.

Manganese.—Manganese is the only metal which is precipitated only as peroxide. It is deposited at once on closing the circuit and is at first brown, then black and shining. Organic acids, ferrous oxide, chromic oxide, ammmonium salts, &c., prevent the formation of peroxide and the red colour produced by permanganic acid. In very dilute strongly acid nitric solutions there is formed only permanganic acid which, according to Riche, is plainly visible in solutions containing $\frac{1}{1000000}$ grm. manganese. On electrolysing a manganiferous solution of copper nitrate red permanganic acid appeared in a stratum floating above the platinum disc coated with brown peroxide. No manganese peroxide was deposited. The peroxide adheres firmly to the platinum when the proportion of free acid is small, not exceeding 3 per cent, and the current is not too strong. If the action of the current is prolonged after the peroxide is thrown down, it falls off in laminæ. According to Riche, in a nitric solution the manganese is deposited as peroxide, also at the negative pole. This formation is not directly due to the current, but is a precipitate occasioned by the production of ammonia by the reduction of nitric acid. To determine the manganese in peroxide electrolytically precipitated, it is heated to bright redness in the platinum capsule until the weight becomes constant. The results are too high.

Selenium and Tellurium.—Both these bodies are readily and completely reduced by the current either in acid or alkaline solutions. Selenium is thrown down at first of a fine brownish red, which gradually becomes darker. The deposit of tellurium is of a bluish black colour. If the current is feeble the deposit of selenium is moderately compact; that of tellurium is always loose, and it often floats on the liquid. A strong current precipitates both as powders. The positive pole is coated during electrolysis with a film of a dark colour in case of selenium, but of a lemon-yellow with tellurium. As in case of arsenic and antimony the hydrogen evolved at the negative pole combines with the reduced substances, forming hydrogen, selenide, or telluride, which remain in part in solution in the liquid. The reduced metal separates out at the anode in a friable condition.—*Zeitschrift für Analytische Chemie.*

METHOD FOR THE DIRECT DETERMINATION OF CHLORINE IN PRESENCE OF BROMINE AND OF BROMINE ALONG WITH IODINE.

By G. VORTMANN.

The author some time back made known a method for the detection and determination of chlorine in presence of bromine and iodine, based on the various behaviour of the three halogens with manganese and lead peroxide in presence of acetic acid. On boiling with lead peroxide and acetic acid the chlorides remain unaffected, whilst the bromides and iodides are completely decomposed, with liberation of bromine and iodine. Manganese peroxide, in presence of acetic acid, is said to act only upon the iodides.

C. L. Müller and G. Kircher have submitted this method to investigation. As regards the action of lead peroxide and acetic acid upon the chlorides, they found that upon boiling such mixtures chlorine is given off in abundance along with carbonic acid, whether the acid employed was glacial or containing from 50 to 10 per cent of real acid. One part sodium chloride boiled for six hours with 10 parts lead peroxide and 20 parts acetic acid at 50 per cent in a cohobator was found to contain only two-thirds of the chlorine originally present. In accordance with their experiments the authors explain this fact by the circumstance that in such proportions sodium chloride and acetic acid yield hydrochloric acid, that this in presence of lead peroxide evolves chlorine, which, reacting upon the acetic acid, forms mono-chloracetic acid, which is in part oxidised with formation of lead chloride, carbonic acid, and free chlorine.

If manganese peroxide is substituted for the lead compound, sodium chloride is, indeed, decomposed, but carbonic acid escapes alone, without chlorine.

Müller and Kircher confirm Vortmann's statement that lead peroxide in presence of acetic acid decomposes the bromides and iodides, whilst, according to their experiments, manganese peroxide and acetic acid act, not upon the iodides alone, but upon the bromides also.

Vortmann has now replied in an elaborate memoir. His observations agree with those of Müller and Kircher so far that, on boiling potassium chloride, lead peroxide, and acetic acid, a perceptible escape of chlorine occurs if the concentration of the acetic acid is over 5 per cent. He finds that not a trace of potassium chloride is decomposed if acetic acid of at most 2 to 3 per cent is employed, and the mixture is evaporated on the water-bath. Even on repeating this process five or six times no loss of chlorine is experienced. The remaining chlorides behave like potassium chloride.

Concerning the behaviour of the chlorides with manganese peroxide and acetic acid, Vortmann states that in presence of strong acetic acid a slight decomposition

occurs, whilst if the acid is dilute there is not the slightest action.

Vortmann corrects his previous statements concerning the behaviour of the bromides to this effect, that they are attacked by manganese peroxide and strongly concentrated acetic acid, but with a dilute acid of 2 to 3 per cent they do not undergo any change.

If the solution of a bromide is mixed with lead peroxide and dilute acetic acid, bromine is immediately liberated, especially if the reaction is assisted by heat. On boiling or evaporation, bromine escapes, so that it is practicable on repeatedly evaporating to dryness on the water-bath, entirely to expel quantities of bromine corresponding to 0·5 potassium bromide. In case of larger quantities of bromine, a twice-repeated evaporation is not sufficient. The reason is that considerable quantities of lead acetate in solution impede the decomposition of the bromide, since the liquid can only be evaporated to a syrup. In such cases the repeated evaporation is dispensed with, and the dissolved lead is thrown down by means of hydrogen sulphide; the precipitate of lead sulphide is then again evaporated down with lead peroxide and acetic acid, when finally the last trace of bromine is driven off.

The decomposition of the iodides by treatment with lead peroxide and acetic acid is complete only when so much lead peroxide is added as corresponds with the following equation:—

$$KI+PbO_2=PbO+KO+I,$$

and the mixture is heated for some time to boiling. In the cold no lead iodate is produced by an excess of lead peroxide; on boiling, however, the iodine is partly oxidised, and considerable quantities of lead iodate are formed; relatively to a greater extent the more iodine is present, small quantities of iodine can be eliminated without oxidation. Manganese peroxide acts upon the iodides much more feebly than does lead peroxide. The decomposition in presence of acetic acid is slower, and there is no formation of iodic acid.

Mixtures of iodides and bromides in acetic solution behave with maganese peroxide like the iodides alone, *i.e.*, iodine alone is eliminated. On applying an excess of lead peroxide, on the other hand, there is simultaneous expulsion of bromine and iodine, which then react upon each other with formation of iodic acid. This change takes place even in the cold, and almost the entire quantity of iodine can be thus converted into iodic acid, so that on heating scarcely anything but bromine escapes. The formation of iodic acid may be almost completely avoided by introducing the lead peroxide into the boiling acetic solution in small successive portions, in order thus to decompose first the iodide and then the bromide. Upon these facts Vortmann founds the following analytical methods:—

For determining chlorine in presence of small quantities of bromine the mixture with lead peroxide and acetic acid of 2 to 3 per cent is twice or thrice evaporated to dryness on the water-bath. The residue is taken up with water and a little acetic acid, filtered, washed with hot water, and the filtrate is precipitated with silver nitrate.

The determination of chlorine in presence of iodine is conducted in the same manner. If the quantity of the iodide is small, lead peroxide is used; but if large, manganese peroxide is preferable. The evaporation with dilute acetic acid must here also be repeated several times. The expulsion of iodine is accelerated by boiling the liquid first for a few minutes in a flask, but this procedure is practicable only with lead peroxide, as, in case of manganese peroxide, violent bumping occurs. In this case the mixture is heated on the water-bath, and a current of air is passed through the liquid.

The determination of bromine in presence of iodine is effected in an analogous manner; the mixture is repeatedly evaporated with manganese peroxide and dilute acetic acid on the water-bath, and air is passed through the liquid to expedite the reaction.

The determination of chlorine in presence of bromine and iodine can be effected by two methods:—The mixture is either boiled with lead peroxide and dilute acetic acid, when the iodides and bromides are simultaneously decomposed, or the iodine is first expelled by evaporation with manganese peroxide and acetic acid, and the bromine is then eliminated by repeating the operation with the addition of lead peroxide.

If the former method is adopted, in order to obviate as far as possible the formation of iodic acid by the mutual action of iodine and bromine, the lead peroxide is introduced into the boiling acetic solution in small portions and in slight excess. After boiling for half an hour, and constantly replacing the water lost by evaporation, the lead which has passed into solution is precipitated with hydrogen sulphide, without previous filtration; the whole, after filtration, is heated for some time on the water-bath, again treated for a short time with sulphuretted hydrogen, and filtered. The filtrate is evaporated to dryness on the water-bath, the residue covered with dilute acetic acid, and, after the addition of some lead peroxide, again evaporated. The evaporation is in any case repeated once more, the residue is finally dissolved, and after filtration the chlorine is determined with silver nitrate.

The results are unsatisfactory when a little chlorine occurs along with large quantities of bromine and iodine. In such cases the following procedure is to be preferred:—

The mixture is repeatedly evaporated down on the water-bath with manganese peroxide and acetic acid at 5 per cent to expel iodine; the bromine is then driven off by evaporating—without previous filtration—repeatedly with lead peroxide and acetic acid at 2½ per cent; the ultimate residue is taken up with water and a little acetic acid, and the chlorine is determined in the filtrate.

This method has the defect that, on decomposing the iodides by manganese peroxide, manganese dissolves, and on subsequent treatment with lead peroxide it is re-precipitated as manganese-lead peroxide. This precipitate requires very prolonged washing with boiling water.—*Zeitschrift fur Analytische Chemie.*

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending January 31st, 1884.

By WILLIAM CROOKES, F.R.S.
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, February 6th, 1884.

Sir,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from January 1st to January 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 189 samples of water, the whole were, without exception, clear, bright, and well filtered.

The water supplied to the Metropolis during January has mantained much the same character as that manifested by the supply of the preceding month; its degree of freedom from organic matter, however, being on the whole somewhat less during the latter part than at the beginning of the month.

Our own report on the character of the supply during the preceding month of December, based on an examination of 182 samples, was as follows:—"Altogether, the condition of the Metropolitan water during the past month, in respect to aëration and freedom from colour and turbidity, has been unexceptionable. In one sample only out of those completely analysed (24) was the amount of organic matter at all excessive, while the mean proportion was low—and unusually low for the period of the year."

On the other hand, the report made to the Registrar-General, also on the character of the waters supplied to the Metropolis *during* the month of December, but based on an examination of 7 samples only, all taken on the same one day of the month, was as follows:—"The Thames water sent out by the Chelsea, West Middlesex, Southwark, Grand Junction, and Lambeth Companies, which in the previous two months had exhibited an increased amount of organic matter, again suffered further deterioration in December. . . . . The water drawn from the Lea and distributed by the New River and East London Companies, underwent a similar, but in the case of the New River, a less marked deterioration, whilst the East London Company's water was scarcely superior to any of the Thames waters."

We have no hesitation in calling attention to the discordance between the two reports; or to the circumstance that, according to the report to the Registrar-General, the mean amount of organic carbon in the Thames derived waters supplied *during* the month of December, 1883, or 0·246 part in 100,000 parts of the water, was identical with the mean amount of organic carbon in the Thames derived waters supplied *during* the month of December, 1882; notwithstanding that throughout December, 1882, the river was in a quite exceptional state of turbidity and flood; whereas at no part of the month of December, 1883, was it in a bad condition for the time of the year, while its condition during the latter part of the month was exceptionally good.

We are, Sir,
Your obedient Servants,
William Crookes,
William Odling,
C. Meymott Tidy.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

URANIUM.

It is not the purpose of the present investigation to examine at all systematically such questions as are involved in the discussion whether the atomic weight of uranium is 120 or 240. For convenience we may use the formulæ based upon the smaller number, and, if eventually the larger value proves to be correct, it will be easy to double the figures which we obtain. Suffice it to say here, that the specific heat of the green oxide, according to Donath,† agrees best with the formula U_3O_4 and the lower atomic weight. On the other hand, the value 240 fits best into such schemes as that given by Mendelejeff in his paper on the periodic law. An accurate determination of the specific heat of the metal itself is much needed, for the material with which Regnault worked was of uncertain quality; furthermore, the vapour density of some volatile uranium compounds ought to be ascertained.* Until some such data have been rigidly established the controversy over the two rival values can hardly be satisfactorily settled.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Ber. d. Deutsch. Chem. Gessel.*, 12, 742. 1879.

The earlier attempts to determine the atomic weight of uranium were all vitiated by the erroneous supposition that the uranous oxide was really the metal. The supposition, of course, does not affect the weighings and analytical data which were obtained, although these, from their discordance with each other and with later and better results, have now only a historical value.

For present purposes the determinations made by Berzelius,† by Arfvedson,‡ and by Marchand,‖ may be left quite out of account. Berzelius employed various methods, while the others relied upon estimating the percentage of oxygen lost upon the reduction of U_3O_4 to UO. Rammelsberg's§ results also, although very suggestive, need no full discussion. He analysed the green chloride, UCl_2; effected the synthesis of uranyl-sulphate from uranous oxide; determined the amount of residue left upon the ignition of the sodio- and bario-uranic acetates; estimated the quantity of magnesium uranate formed from a known weight of UO, and attempted also to fix the ratio between the green and the black oxides. His figures vary so widely that they could count for little in the establishing of any general mean; and, moreover, they lead to estimates of the atomic weight which are mostly below the true value. For instance, twelve lots of U_3O_4 from several different sources were reduced to UO by heating in hydrogen. The percentages of loss varied from 3·83 to 4·67, the mean being 4·121. These figures give values for the atomic weight of uranium ranging from 92·66 to 117·65, or, in mean, 107·50. Such discordance is due partly to impurity in some of the material studied, and illustrates the difficulties inherent in the problem to be solved. Some of the uranoso-uranic oxide was prepared by calcining the oxalate, and retained an admixture of carbon. Many such points were worked up by Rammelsberg with much care, so that his papers should be scrupulously studied by any chemist who contemplates a re-determination of the atomic weight of uranium.

In 1841 and 1842 Peligot published certain papers¶ showing that the atomic weight of uranium must be somewhere near 120. A few years later the same chemist published fuller data concerning the constant in question, but in the time intervening between his earlier and his final researches other determinations were made by Ebelmen and by Wertheim. These investigations we may properly discuss in chronological order. For present purposes the early work of Peligot may be dismissed as only preliminary in character. It showed that what had been previously regarded as metallic uranium was in reality an oxide, but gave figures for the atomic weight of the metal which were merely approximations.

Ebelmen's** determinations of the atomic weight of uranium were based upon analyses of uranic oxalate. This salt was dried at 100°, and then, in weighed amount, ignited in hydrogen. The residual uranous oxide was

* The value of 240 for uranium is strongly sustained by the recent experiments of Zimmermann upon the vapour density of the tetrachloride and tetrabromide. For UBr_4 the vapour density is 19·46, while theory (U=240) requires 19·36. For UCl_4 the v. d. 13·33 was found. Theory, 13·21. (*Ber. der Deutsch. Chem. Gessel.*, 14, s. 1934 1881.) Zimmermann has also (*Ber.*, 15, 847) determined the specific heat of uranium, and finds it to be 0·02765. This, multiplied by 240, gives 6·64, in agreement with the usual values under Dulong and Petit's law.
† *Schweigg. Journ.*, 22, 336. 1818. *Poggend. Annal.*, 1, 359. 1825.
‡ *Poggend. Annal.*, 1, 245. *Berz. Jahr.*, 3, 120. 1822.
‖ *Journ. f. Prakt. Chem*, 23, 497. 1841.
§ *Poggend. Annal.*, 55, 318; 1842; 56, 125, 1842; 59, 9, 1843; 66, 91, 1845. *Journ. f. Prakt. Chem.*, 29, 324.
¶ *Compt. Rend.*, 12, 735. 1841. *Ann. Chim. Phys.*, (3), 55. 1842.
** *Journ. f. Prakt. Chem.*, 27, 358. 1842.

weighed, and in some cases converted into U_3O_4 by heating in oxygen. The following weights are reduced to a vacuum standard:—

		Gain on Oxidation.
10·1644 grms. oxalate gave	7·2939 grms. UO.	
12·9985 ,,	9·3312 ,,	0·3685
11·8007 ,,	8·4690 ,,	0·3275
9·9923 ,,	7·1731 ,,	0·2812
11·0887 ,,	7·9610 ,,	0·3105
10·0830 ,,	7·2389 ,,	
6·7940 ,,	4·8766 ,,	
16·0594 ,,	11·5290 ,,	0·4531

Reducing these figures to percentages, we may present the results in two columns. Column A gives the percentages of UO in the oxalate, while B represents the amount of U_3O_4 formed from 100 parts of UO:—

A.	B.
71·924	—
71·787	103·949
71·767	103·867
71·621	103·920
71·794	103·900
71·793	—
71·778	—
71·790	103·930
Mean 71·782 ± 0·019	Mean 103·913 ± 0·009

From col. A the mol. weight of UO = 134·523 ± 0·102
,, B ,, ,, 135·985 0·326

General mean UO = 134·652 0·097

From column A .. .. U = 118·560
,, B .. .. ,, 120·022
From general mean of both columns ,, 118·689 ± 0·097

Wertheim's* experiments were even simpler in character than those of Ebelmen. Sodio-uranic acetate, carefully dried at 200°, was ignited, leaving the following percentages of sodium uranate:—

67·51508
67·54558
67·50927

Mean 67·52331 ± 0·0076

Hence the molecular weight of $Na_2U_4O_7$ = 634·865 ± 0·191. And U = 119·282 ± 0·048.

The final results of Peligot's† investigations appeared in 1846. Both the oxalate and the acetate of uranium were studied and subjected to combustion analysis. The oxalate was scrupulously purified by repeated crystallisations, and thirteen analyses representing different fractions, were made. Seven of these gave imperfect results, due to incomplete purification of the material; six only, from the later crystallisations, need to be considered. In these the uranium was weighed as U_3O_4, and the carbon as CO_2. From the ratio between the CO_2 and U_3O_4 the atomic weight of uranium may be calculated without involving any error due to traces of moisture possibly present in the oxalate. I subjoin Peligot's weighings, and give, in the third column, the U_3O_4 proportional to 100 parts of CO_2:—

CO_2.	U_3O_4.	Ratio.
1·456 grms.	4·649 grms.	319·299
1·369 ,,	4·412 ,,	322·279
2·209 ,,	7·084 ,,	320·688
1·019 ,,	3·279 ,,	321·786
1·069 ,,	3·447 ,,	322·461
1·052 ,,	3·389 ,,	322·148
		Mean 321·443 ± 0·338

Hence U_3O_4 = 423·342 ± 0·451.

* *Journ. f. Prakt. Chem.*, 29, 209. 1843.
† *Compt. Rend.*, 22, 487.

From the acetate, $C_2H_3(UO)O_2.H_2O$, the following percentages of U_3O_4 were obtained:—

5·061 grms. acetate gave	3·354 U_3O_4.	66·2715 per cent.
4·601 ,,	3·057 ,,	66·4421 ,,
1·869 ,,	1·238 ,,	66·2386 ,,
3·817 ,,	2·541 ,,	66·5706 ,,
10·182 ,,	6·757 ,,	66·3622 ,,
4·393 ,,	2·920 ,,	66·4694 ,,
2·868 ,,	1·897 ,,	66·1437 ,,
		Mean 66·3569 ± 0·038

The acetate also yielded the subjoined percentages of carbon and of water. Assuming that the figures for carbon were calculated from known weights of dioxide, with C = 12 and O = 16, I have added a third column, in which the carbon percentages are converted into percentages of CO_2:—

H_2O.	C.	CO_2.
21·60	11·27	41·323
21·16	11·30	41·433
21·10	11·30	41·433
21·20	11·10	40·700
Mean 21·265 ± 0·187	11·24	Mean 41·222 ± 0·092

From all of these figures we may calculate the molecular weight of the uranic acetate as follows:—

From percentage of U_3O_4.. ..	$C_2H_3(UO)O_2.H_2O$ =	212·629 ±	0·242
Ditto CO_2	,,	212·999	0·476
,, H_2O.. ..	,,	211·184	1·863
General mean ..	,,	212·685	0·214

We have now before us the molecular weights of four uranium compounds, giving us four values for U:—

(1.) UO = 134·652 ± 0·097 .. .. Ebelmen.
(2.) $Na_2U_4O_7$ = 634·865 ± 0·191 .. .. .. Wertheim.
(3.) U_3O_4 = 423·342 ± 0·451 .. .. Peligot.
(4.) $C_2H_3(UO)O_2.H_2O$ = 212·685 ± 0·214 .. ,,

The four values for uranium combine as follows:—

From (1)	U = 118·689 ±	0·097	Ebelmen.
,, (2)	,, 119·282	0·048	Wertheim.
,, (3)	,, 119·830	0·150	Peligot.
,, (4)	,, 119·885	0·215	,,
General mean	,, 119·241	0·041	

Or, if O = 16, U = 119·515, or 239·030.

Considering Peligot's figures by themselves, and combining values 3 and 4, we have U = 119·849 ± 0·123; or, if O = 16, U = 120·125, or 240·250.

It is plain that the atomic weight of uranium needs to be scrupulously revised. The foregoing figures are by no means satisfactory. Chemically considered, it is probable that Peligot's work is the best, and that his results should be given preference. His figures from the oxalate and the acetate tally well with each other, whereas Ebelmen's two sets of results vary widely. From the percentage of UO yielded by the oxalate, Ebelmen's figures give a low value for U. From his oxidation of UO to U_3O_4 we get a value nearly two units higher. Peligot, in his work with the oxalate, found it, even after three or four crystallisations, to be contaminated with oxalic acid, and rejected the figures obtained from impure material. Probably Ebelmen's low values are due to the same impurity.

The Action of Chloro-carbonic Oxide upon Æthylen-glycol.—J. Nemirowsky.—The author has obtained glycol carbonate, hitherto unknown, by allowing 1 mol. pure glycol and 1 mol. liquid chloro-carbonic acid to act upon each other in a sealed tube at common temperatures. —*Journal fur Praktische Chemie.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, February 23, 1884.

Prof. F. Guthrie, President, in the Chair.

New Members—Mr. E. F. J. Love, Mr. James Grundy, Rev. F. J. Smith, Mr. F. R. Bawley.

Prof. Silvanus P. Thompson read a paper on "*A New Method of making Resistance Coils.*" This consisted in cutting off a piece of the wire of which the coil is to be made, long enough to give a resistance some 2 per cent higher. From the formula—

$$\text{Shunt} = \frac{Rr}{R-r}$$

(where R is the rough resistance, and r the final resistance), the value of a wire wherewith to shunt the first piece in order to give the resistance required is found. A length of wire giving this resistance (or rather about 2 per cent more) is then cut off and soldered as a shunt to the first piece. Practice shows that this method is very quick and accurate. It is useful for shunts under 10 ohms.

Prof. Thompson also described a new form of "Meter Bridge," devised by him. The wire is 2 metres long, and there are two wires, one of a resistance about $\frac{1}{4}$ ohm, the other 8·21 ohms. Contact is made with one or other by a sliding contact with vernier attached. This arrangement is more convenient than the single wire meter bridge, and allows of higher resistances being measured. A special switch board with an arrangement of mercury cups avoids the necessity of transposing the coils in Foster's method; this being effected by shifting the contact links in the mercury cups.

Mr. R. T. Glazebrook, F.R.S., explained a cam or axle-key, devised by Mr. Shaw, to effect the contacts necessary to transpose the coils by a single movement. He pointed out that a certain pressure was necessary to make good contact with mercury. The ordinary way of making coils was to double the wire, cut the bight, bare the ends there, and solder a piece of copper across them, which could be shifted until the resistance was got.

Prof. G. C. Foster said that the copper links in mercury cups should rest on the copper.

Prof. Foster read a paper by himself and Mr. Pryson, "*On the Difference of Potential required to give Sparks in Air.*" Let V = this difference of potential, l = length of spark in centimetres; their experiments gave (approximately), $V = 102\ l + 7·07$. Tables and curves of the sparking distances, potentials, and electric forces in the experiments were given. The results were got with brass balls 1·35 centimetres in diameter, a frictional machine, and a Foster absolute electrometer. When l = 0·142, the electric force giving a spark was 154·76; l = 0·284, the electric force was 133·35, or less than at a shorter distance; l = 0·497, the electric force was 131·66: l = 0·9, the electric force was 138·57, that is, it began to rise again.

Prof. G. Forbes made a communication "*On a Magnetised Chronometer Watch.*" The watch slowed several minutes a day. He found the rate to vary with the position of the watch with respect to the north cardinal point, and also in a vertical plane. The bar of the balance was magnetised, and some screw nails. He traced the variation of rate to magnetisation of the spring, the bar, and screws. The fact that it varied with position suggested that a magnetised ship's chronometer might be made which would integrate the course and give a mean course. Messrs. E. Dent and Co. had fitted a gold spring and a platinum iridium balance to the chronometer, and rendered it non-magnetisable.

NOTICES OF BOOKS.

Botanical Micro-Chemistry, an Introduction to the Study of Vegetable Histology, prepared for the Use of Students. By V. A. Poulsen. Translated with the assistance of the Author and considerably enlarged by W. Trelease, Professor in the University of Wisconsin. Boston: Cassino and Co. London: Trübner and Co.

Passing over the three prefaces to this work we come to an Introduction, in which the author points out the scope and the importance of micro-chemistry; in other words, the changes produced on organised bodies by certain reagents, as seen under the microscope. Professor Poulsen discusses firstly the chemicals to be used as reagents, and secondly the vegetable substances to be sought for and the reactions by which they are known.

The enumeration of micro-chemical reagents is very complete, especially as regards the colouring agents used for the differentiation of the tissue-systems and for the recognition of the cell-contents. Here, however, we find a peculiarity in nomenclature. The author speaks repeatedly of "fuchsin." We know that this name is applied in France and Germany, and latterly in America, to the salts of rosaniline. Now, we always protest against this name, firstly as being incapable of pronunciation by any Englishman who is not versed in the German tongue, but secondly and mainly because, like its kindred colour-names peonine and azaleine, it conveys the false idea of a proximate vegetable principle. But a couple of pages further we meet with "magenta," spoken of as if it were another substance. Surely the author, or the translator, must know that magenta is the technical English name for the salts of rosaniline, and is consequently synonymous with fuchsin!

As an appendix to this part we find an account of the best media for mounting microscopic preparations.

The second section of the work gives a good description of vegetable substances and the methods for their recognition.

The work is provided with a good index and a bibliography of micro-chemistry.

To the student of vegetable histology this book will prove a safe and welcome guide.

Year-Book of Pharmacy: Comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry, contributed to British and Foreign Journals from July 1st, 1882, to June 30th, 1883; with the Transactions of the British Pharmaceutical Conference at the Twentieth Annual Meeting, held at Southport, September, 1883. London: J. and A. Churchill.

This useful volume opens with an introductory summary of progress in materia medica, pharmacy, and chemistry. Next follow abstracts of the most important papers in connection with these subjects which have appeared in the scientific journals. Many of the paragraphs are of course not of very recent date, but they are here presented in a convenient form for reference. The solubility of lead sulphate in ammonium citrate mentioned by S. Rovera, seems a case of "re-discovery." It has been known for about 30 years.

In some cases there appears to be a difficulty in drawing the line between the departments of chemistry and pharmacy. In both we find analytical procedures. Under pharmacy figure such paragraphs as "The Adulteration of Cochineal" and the "Valuation of Commercial Extracts of Logwood," the method recommended for the detection of glucose or treacle being the addition of yeast. We should much prefer to dye comparative swatches of cloth.

The difficult question of antiseptics and disinfectants is dealt with at some length, and many interesting results are quoted. "Notes and Formulæ" includes receipts of a

very varied nature for the preparation of medicines, cements, inks, perfumes, and even blacking.

"Bibliography" is a very useful section, giving the titles of such books, pamphlets, &c., on chemistry, pharmacy, materia medica, and kindred subjects as have appeared between July 1st, 1882, and June 30th, 1883. The works on chemistry amount to 90, those in the English language being in a very decided minority. Here again we find a peculiarity of classification. The "Précis de Toxicologie" of Chappuis is placed under "Materia Medica," whilst Dragendorf's "Beitrage zur Gerichtlichen Chemie" ranks under chemistry.

The Presidential address delivered by Prof. Attfield at the meeting of the Pharmaceutical Conference deals largely with what may be called pharmaceutical legislation. The speaker advocates increased restrictions on the sale of poisons. Now, unfortunately, these substances, or at least many of them, are of frequent and important use in the arts, and there is room to fear that the proposed measures may seriously interfere with experiment and invention. This view seems to be taken by the Government, since, according to Dr. Quinlan, an "amended schedule" of poisons was sent in, and a letter from the Under Secretary replied that "the addition of these things to the schedule would interfere with the course of trade and manufactures." This is a very serious point. If the purchase, *e.g.*, of the ordinary mineral acids is to be hedged round with tedious formalities, chemical research will be almost limited to men who have already achieved a high position.

But with the proposal to place further restrictions on the sale of medicinal substances not used in the chemical arts or in scientific investigation we can cordially sympathise. Many proprietary medicines contain formidable poisons, and yet they are at present to be procured in any quantity, not merely from grocers and oilmen, but especially from the monopolising class of drapers, now so plentiful in our large towns.

CORRESPONDENCE.

ZINC IN DRINKING-WATER.

To the Editor of the Chemical News.

Sir,—My friend Mr. Heaton very properly draws attention to the occasional presence of zinc in potable water. That this metal exists in solution in some waters when kept in contact with the metal has, however, been long known, and has been the subject of repeated investigation. In the "Guy's Hospital Reports" for 1872, vol. xvii. [3rd series], p. 233, is a short paper by myself (see page 107), embodying, as I believe, all that was then known on the subject.—I am, &c.,

Thomas Stevenson.

February 27, 1884.

ZINC IN DRINKING-WATER.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xlix., p. 85, you publish a note on this subject by Prof. C. W. Heaton. As Prof. Heaton states that he believes the solvent action of water on zinc not to have been observed before, may I be permitted space to make the following remarks?

In the Sixth Report of the Rivers' Pollution Commission, p. 226, in treating of the action of water upon lead, it is pointed out that certain polluted shallow well waters, containing much dissolved oxygen and but little carbonic acid, possess the property of acting continuously both on bright and tarnished lead, and that when galvanised iron pipes are substituted, the water is found to be impregnated with zinc instead of lead. The following analytical figures show the composition of a shallow well-water of this kind, which was the cause of a serious case of lead-, and subsequently of zinc-poisoning:—

Results of Analysis expressed in parts per 100,000.

Dissolved Matters.							Hardness.		
Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Chlorine.	Temporary.	Permanent.	Total.
23·28	0·109	0·038	0·026	0·062	0·121	4·0	1·0	9·4	10·4

Remarks.—Clear, palatable. No nitrites. No phosphates.

100 cubic inches of this water contained in solution:—

Nitrogen	1·3409 cub. ins.
Oxygen	0·6091 ,,
Carbonic acid	1·4531 ,,
	3·4031 ,,

The Loch Katrine water, which acts both on bright and tarnished lead, also attacks galvanised iron. The presence of zinc in water is easily recognisable by the thin white film which forms on the surface of the water, when the latter is exposed to the air. Rain-water apparently does not attack galvanised iron under ordinary circumstances, but if intended for drinking, its storage in tanks of this material is probably attended with some risk.—I am, &c.,

Percy F. Frankland.

Grove House, Pembridge Square, W.,
February 27, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Journal für Praktische Chemie.
New Series, Vol. xxviii., Part 9.

The Elementary Composition of Certain Kinds of Wood, along with Calorimetric Experiments on their Combustibility.—E. Gottlieb.—In this elaborate paper the author gives the analysis of specimens of oak, ash, beech, hornbeam, birch, pine, and red fir, along with an account of the soils in which the respective trees had grown. The ultimate analyses of the organic matter are collected in the form of tables, which do not admit of abridgment. In the second section of the memoir the number of calories obtained by the combustion of known weights of the woods is given. The highest rank as a heat generator is assigned to *Pinus abies*, probably *Abies excelsa*, the spruce fir. The author concludes that in the combustion of wood more heat is evolved than the quantity calculated by Dulong's formula from the elementary composition.

Trichloro-quinone-chlorimide, Tri-, and Tetra-chlor-quinone.—M. Andresen.—A study of the behaviour of trichloro-quinone, tetra-chloro-quinone, and trichloro-quinone-chlorimide with aniline, the properties of mono-chlor-dianilido-phenyl-quinonimide, a product of the reaction of the two bodies last mentioned, its behaviour with nitrous acid, alkalies, and hydrochloric acid, and the action of hydrobromic and hydriodic acid upon trichloro-quinon-chlorimide.

Di-iodo-quinone and Di-iodo-quinon-chlorimide.—R. Seifert.—A preliminary announcement.

The Real Types of Organic Compounds.—H. Kolbe.—The author considers carbonic acid as the type

of acetic acid and of the carbon acids in general; sulphuric acid as the type of the sulphones and of sulphonic acids; sulphurous acid as type of the triethyl-sulphine compounds; ammonia as type of methylamine, &c.; arsenic acid as type of kakodylic acid, and arsenious acid as type of kakodyl oxide.

Vol. xxviii., Parts 10 and 11.

Studies in Chemical Dynamics.—W. Ostwald.—A very important paper, which does not admit of useful abridgment.

Remarks on F. Salomon's Memoir on "Starch and its Transformations under the Influence of Acids."—F. Musculus.—The author points out several errors in the memoir of Salomon.

Bulletin de la Société Chimique de Paris.
Vol. xli., No. 3, February 5, 1884.

Notes on the Observations of M. Spring.—Ed. Jannettaz.—The author has not obtained any decisive evidence of crystallisation produced by pressure. As regards the production of combinations by the same agency M. Jannettaz holds that this phenomenon where it occurs is due to the enormous quantity of heat liberated by strong pressure.

Second Anhydride of Mannite.—A. Fauconnier.—The author has obtained and examined iso-mannide, an isomer of the mannide of Berthelot. He has made a particular study of its ethers.

Action of Cyanogen upon the Toluidines.—J. A. Bladin.—Gaseous cyanogen is readily absorbed by an alcoholic solution of para-toluidine, forming a crystalline mass of a basic character, which produces colourless compounds with acids. The ortho compound is obtained in an analogous manner, and is similar in its properties, but dissolves more readily in alcohol. The meta compound is also obtained in a corresponding manner. From its mother-liquors there is deposited a compound in small red crystals, which the author has not yet examined.

Die Chemische Industrie.
Vol. 7, No. 1, January, 1884.

Report of the Workmen's Insurance Commission.—The General Assembly of the Association for Promoting the Chemical Industry of Germany appointed, at its meeting in September last, to inquire into the best means of securing proper care for invalid workmen, &c., have issued their report. It was considered that a charge on every chemical manufactory at the rate of 15 marks per head of the persons employed would meet the exigencies of the case.

Processes in the Lead Chambers.—G. Lunge and P. Naef.—This paper is a further expansion of that by Dr. Lunge, recently inserted in the Chemical News.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin,
Vol. 16, No. 8.

Pyro-sulphuryl Chloride.—D. Konowalow.—MM. Heumann, Kœchlin, and Billitz have published results on this compound confirming the author's views (*Comptes Rendus*, xlv., 1284) on the cause of the deviation of its vapour-density from the law of Avogadro, and adding a hypothesis of their own, that this body undergoes a decomposition during the determination of its vapour-density. This assumption the author does not regard as justified by facts.

Substituted Pyromucic Acids.—H. B. Hill.—The author has studied the formation of bromo-pyromucic acids, of the two dibromo-succinic acids formed along with fumaric acid, and the production of dibrom-furfuran-tetra-bromide.

Violuric Acid.—M. Ceresole.—The author regards violuric acid as an iso-nitroso compound, and has effected its synthesis from hydroxylamine and alloxan.

A New Homologue of Resorcin.—F. Pfaff.—The author has obtained a compound which he names xylorcine. It crystallises in octagonal tables, perfectly transparent, fusible at 124·5° to 125° soluble in hot and cold water, in alcohol and ether, and possessing a strongly acid taste.

Examination of Fats.—Karl Zulkowsky.—Inserted in full.

Copper Sulphide in a Colloidal State.—W. Spring.—Inserted in full.

Potassium Carbonate.—E. A. Flückiger.—The author refers to a potassium carbonate which he described in 1856 in the *Schweizerischen Zeitschrift fur Pharmacie.* It was formed as an efflorescence in an open earthenware box which had contained crude potash. It formed white crystalline needles, permanent in the air; its solution in water did not precipitate magnesium sulphate. The salt, though formed from crude potash, contained neither chlorine nor sulphuric acid. He considers that it contains a pyrocarbonic acid or polycarbonic acid, $C_3O_8H_4$.

Behaviour of Carbo-trithio-hexa-bromide when Heated, and Formation of a Peculiar Colouring-Matter.—C. Hell and Fr. Urech.—If $C_2S_3Br_6$ is heated above its melting-point (125°) it takes a deep brown colour. About 180° a brown liquid, containing free bromine, distils over, and a deep blue powdery mass remains behind. If the distillate is re-distilled, it leaves more of the blue compound. This pigment is practically insoluble in water, alcohol, ether, and glacial acetic acid. It dissolves with a splendid blue colour in sulphuric acid and in phenol. The solution, if shaken up with zinc powder, turns brown. It dissolves in aniline with a brown colour, but undergoes a chemical change. Its composition is $C_9Br_4S_4,2H_2O$.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Redonda Phosphate.—What is the average composition of this mineral as shipped in large quantity, especially as regards the contents of iron? Where could I get a sample of the mineral?—T. B.

MEETINGS FOR THE WEEK

Saturday, Mar. 8.—Medical, 8.30. (Anniversary.)
Monday, Mar. 10th.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S.
Tuesday, 11th.—Institute of Civil Engineers, 8.
— Photographic, 8.
— Royal Medical and Chirurgical, 8.
— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
Wednesday, 12th.—Society of Arts, 8. "Water Regulation in regard to Floods, Drainage, and Transit," by Lieut.-General F. H. Rundall, R.E., C.S.I.
— Microscopical, 8.
Thursday, 13th.—Royal, 4.30.
— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
— London Institution, 7.
— Society of Arts, 8. "The Upper Thames as a Source of Water Supply," by Dr. Percy F. Frankland.
— Royal Society Club, 6.30.
Friday, 14th.—Royal Institution, 8. "Mesmerism," by Mr. J. N. Langley, at 9.
— Astronomical, 8.
— Quekett Microscopical Club, 8.
Saturday, 15.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

THE CHEMICAL NEWS.

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NOTE ON AN OBSERVATION BY PROFESSOR HARTLEY.

By EILHARD WIEDEMANN.

Prof. Hartley* has found that on moistening the electrodes the spectral lines appear longer than when they are dry, and believes that the cause of this phenomenon is the lowering of the temperature of the electrodes. In support of this theory he finds that by heating the electrodes directly the lines become shorter. I believe this explanation to be not quite exact. On moistening the electrodes the discharge will produce oxyhydrogen gas, which will re-combine at some distance from the electrode and will produce then a large quantity of heat, which will increase the temperature of the metallic vapours. In heating the electrodes directly, we lower the potential that is necessary to produce a spark, so that at each discharge a smaller quantity of matter is dispersed and heated to less degree, the lines must therefore appear shorter.

Leipsig, February.

NOTES ON THE VOLUMETRIC ESTIMATION OF IRON.

By R. W. ATKINSON, B.Sc. (Lond.), F.C.S., F.I.C.

In the analysis of an iron ore differences in the percentage of iron amounting to 1 per cent and above may frequently be observed between the results obtained by different chemists, although the numbers obtained by the same chemists may agree within one-tenth of a per cent. In many cases the practice is to refer the sample for analysis only when the results of the buyer's and the seller's chemists differ by more than 1 per cent: if the differences are less the custom is to buy upon the mean of the two figures. There may be several causes of this variation in the analyses (leaving out of consideration the question of any bias one way or the other), some tending to raise the percentage of iron, and others to diminish it. In all cases where volumetric methods are employed, the first and most important point to be considered is how to obtain the standard solution invariably of an accurately known strength, and it is from a variation in the methods employed for this end that a large amount of the variation in the results above alluded to is due. Presuming that potassic dichromate is the salt almost universally employed in England, in seems simple enough to weigh out the exact amount of salt and dissolve it in a known volume of pure distilled water. Some chemists recommend the fusion of the dichromate for the purpose of driving off completely the water entangled in the crystals; but if this be done, however carefully the heat be regulated, on dissolving in water and allowing to settle, a green deposit of chromic oxide will be found at the bottom of the flask or bottle, showing that a small amount of decomposition takes place during fusion, and that the value of the standard must be lower than the calculated value. Instead of fusing the salt it is much better to grind up the very purest crystals and to dry them in a steam-oven for several hours before weighing out. But, however the solution be made up, it is always safer to standardise it before use, a proceeding which I believe is general, though without great care it may lead to hopelessly erroneous results, as will be seen immediately.

The great difficulty in the use of salts of iron for standardising is to obtain one which will not alter in composition by keeping for two or three months. Ferrous sulphate is out of the question; and most specimens of the sulphate of iron and ammonium are liable to oxidation, though in a less degree than the ferrous sulphate. We have been fortunate enough to get from Messrs. Hopkin and Williams a sample of granulated sulphate of iron and ammonium, which, after several months' use, still gives the theoretical percentage of iron, ammonia, and sulphuric acid.

Best of all substances for standardising is absolutely pure ferric oxide, a substance, however, which is somewhat difficult to prepare of absolute purity. Besides the risk of taking up silica from glass vessels, and the difficulty of removing alkali, even when the perfectly pure ferric hydrate has been obtained, there is still the difficulty of igniting it without the risk of the reducing gases from the burner changing its composition. The ignition is best carried out in a muffle, if one is available.

In a large number of cases steel borings are now used for the purpose of standardising the dichromate solution. The exact composition of the steel is first determined: a weighed quantity is dissolved in dilute sulphuric acid, boiled, and then titrated by means of dichromate. As we are told that organic matter does not reduce potassic dichromate, it is assumed that the hydrocarbons formed during the solution of steel are equally without effect upon it, but the tabulated experiments which follow will, I think, cast some doubt upon this assumption. Three series of experiments have been made with solutions of potassic dichromate prepared on eight different occasions, in order to arrive at the true value of the solution in terms of metallic iron.

In the first column of Table I. the strength of the solutions, as indicated by the specimen of sulphate of iron and ammonium above referred to, is given. In the second column the standard of each solution is given, determined by dissolving a known weight of the steel in nitric acid, evaporating to dryness with hydrochloric acid to expel the nitric acid, dissolving the residue in hydrochloric acid, neutralising, reducing with ammonic bisulphite, diluting with boiling water, adding dilute sulphuric acid, and boiling for half-an-hour to expel all sulphurous acid. The liquid was then titrated with potassic dichromate solution. In the third column are given the numbers obtained by dissolving the same steel in dilute sulphuric acid, boiling, and titrating the solution with dichromate.

The composition of the steel (a piece of Bessemer rail) used in all the experiments (except solution F.) is given below:—

Fe	97·90
C	0·50
Si	0·08
S	0·15
P	0·09
Mn	1·50
	100·22

For facility of comparison the mean results of the experiments tabulated in Table I. are collected in Table II., and in addition, in columns 3 and 5, are given the differences between the standards obtained by solution of steel in sulphuric acid and those obtained by solution of the sulphate of iron and ammonium on the one hand, and by solution of steel in nitric acid on the other.

In the lowest row of Table II. the average values of the standards of the last five solutions, determined in each of the three ways mentioned, will be found, together with the differences between the standard found by dissolving steel in sulphuric acid, and by each of the two other methods.

* Chemical News, vol. xlviii., p. 195.

TABLE I.

Experiments to Determine the True Value of a Solution of Potassic Dichromate.

Sulphate of Iron and Ammonium.

	Wght. of Salt used.	Wght. of Iron.	C.c. used.	1 c.c. =Fe.
		A Solution.		
(1)	1·7600	0·2657	44·9	0·005920
(2)	1·7500	0·2643	44·9	0·005880
(3)	1·5000	0·2143	38·2	0·005610
			Mean ..	0·005803
		B Solution.		
(1)	1·7502	0·25003	42·4	0·005897
(2)	1·6608	0·23725	40·3	0·005887
(3)	1·5000	0·21430	36·4	0·005887
(4)	1·0000	0·14286	24·25	0·005890
			Mean ..	0·005890
		C Solution.		
(1)	1·0000	0·14286	28·60	0·004995
(2)	1·0000	0·14286	28·55	0·005004
			Mean ..	0·004999
		D Solution.		
(1)	1·9000	0·27143	53·95	0·005031
(2)	2·0000	0·28570	57·00	0·005013
			Mean ..	0·005022
		E Solution.		
(1)	2·2998	0·32857	54·80	0·005996
(2)	1·9000	0·27143	45·35	0·005985
(3)	2·2018	0·31454	52·45	0·005997
			Mean ..	0·005993
		F Solution.		
(1)	1·8998	0·27140	54·3	0·004998
(2)	2·0002	0·28570	57·0	0·005012
(3)	1·9998	0·28569	57·1	0·005003
			Mean ..	0·005004
		G Solution.		
(1)	1·9008	0·27154	54·35	0·004996
(2)	1·9999	0·28570	57·20	0·004995
			Mean ..	0·004996
		H Solution.		
(1)	1·9000	0·27143	45·40	0·005979
(2)	2·0000	0·28571	47·75	0·005983
(3)	1·9004	0·27148	45·40	0·005980
			Mean ..	0·005981

Steel dissolved in HNO_3, evaporated with HCl, reduced and titrated.

	Wght. of Steel.	Wght. of Iron.	C.c. used.	1 c.c. = Fe.
		C Solution.		
(1)	0·2443	0·23941	47·9	0·00500
				0·00500
		D Solution.		
(1)	0·2790	0·27342	54·3	0·005035
(2)	0·3535	0·34643	68·9	0·005028
			Mean ..	0·005031
		E Solution.		
(1)	0·2785	0·27293	45·55	0·005992
(2)	0·3511	0·34408	57·60	0·005973
(3)	0·2936	0·28773	48·10	0·005982
(4)	0·4400	0·43120	71·90	0·006000
			Mean ..	0·005987
		*F Solution.**		
(1)	0·2726	0·26715	53·4	0·005002
(2)	0·3284	0·32180	64·15	0·005016
			Mean ..	0·005009
		G Solution.		
(1)	0·2794	0·27381	54·80	0·004997
(2)	0·2831	0·27744	55·55	0·004994
			Mean ..	0·004996
		H Solution.		
(1)	0·3353	0·32859	54·95	0·005980
(2)	0·3333	0·32663	54·65	0·005977
			Mean ..	0·005979

Steel dissolved in dilute H_2SO_4, boiled, and titrated.

	Wght. of Steel.	Wght. of Iron	C.c. used.	1 c.c. = Fe.
		A Solution.		
(1)	0·1120	0·10976	19·9	0·005515
(2)	0·1608	0·15758	28·5	0·005530
(3)	0·1688	0·16540	29·7	0·005560
(4)	0·1014	0·09940	17·9	0·005550
(5)	0·2398	0·23500	42·55	0·005520
(6)	0·2508	0·24580	44·25	0·005550
			Mean ..	0·005538
		B Solution.		
(1)	0·2244	0·21990	37·6	0·005850
(2)	0·3222	0·31576	53·9	0·005860
(3)	0·2423	0·23745	40·6	0·005850
(4)	0·2513	0·24627	42·1	0·005850
			Mean ..	0·005852
		C Solution.		
(1)	0·2098	0·2056	41·4	0·004966
(2)	0·1990	0·19502	39·35	0·004956
			Mean ..	0·004961
		D Solution.		
(1)	0·2680	0·26264	52·65	0·004990
				0·004990
		E Solution.		
(1)	0·3163	0·30997	52·10	0·005950
				0·005950
		*F Solution.**		
(1)	0·2744	0·26890	54·10	0·004975
(2)	0·3250	0·31850	64·00	0·004980
			Mean ..	0·004978
		G Solution.		
(1)	0·2551	0·24999	50·35	0·004965
Steel disslvd. in HCl in current of CO_2.				
(2)	0·2803	0·274694	55·20	0·004975
			Mean ..	0·004970
		H Solution.		
(1)	0·3012	0·295176	49·65	0·005945
(2)	0·3532	0·346136	58·20	0·005947
Steel disslvd. in HCl in current of CO_2.				
(3)	0·3291	0·32252	54·05	0·005967
			Mean ..	0·005953

* Standardised with a different sample of steel containing Fe, 99·45 per cent; C, 0·139 per cent.

It will be observed that whilst the average strength of the solutions found by the use of sulphate of iron and ammonium (0·0053986) agrees very closely with that obtained by dissolving the steel in nitric acid and evaporating (0·0053994), both are considerably higher than the number obtained by solution of the steel in sulphuric acid (0·0053656). It follows, of course, that the differences between each of the two former and the latter are almost

TABLE II.

Abstract of Results in Table I. Averages.

No. of Solution.	Sulphate of Iron and Ammonium. I.	Difference between I. and II.	Steel dissolved in Sulphuric Acid. II.	Difference between III. and II.	Steel dissolved in Nitric Acid. III.
A	0·005803	—	0·005516	—	—
B	0·005890	0·000038	0·005852	—	—
C	0·004999	0·000038	0·004961	—	—
D	0·005022	0·000032	0·004990	0·000041	0·005031
E	0·005990	0·000040	0·005950	0·000032	0·005982
F	0·005004	0·000027	0·004977	0·000032	0·005009
G	0·004996	0·000031	0·004965	0·000031	0·004996
H	0·005981	0·000035	0·005946	0·000033	0·005979
Average D to H	0·0053986	0·0000330	0·0053656	0·0000338	0·0053994

identical, viz., 0·0000330 and 0·0000338. These numbers may appear very small, but they are not insignificant, inasmuch as the difference of a unit in the fifth decimal place with a 50-per cent ore, using half-a-gramme, means a difference of one-tenth per cent; and hence by using one or other of the above methods for standardising it is possible to have differences of more than one-third of a per cent. Too low results will therefore always be obtained when the dichromate solution is standardised by dissolving steel in dilute sulphuric acid.

The only probable explanation of the above observations seems to be that the hydrocarbons liberated during the solution of steel in sulphuric acid do possess some reducing action upon solution of potassic dichromate, though it is remarkable that the differences in Solution F seem almost as marked as in the other solutions, although in that case a mild steel was employed containing only 0·14 per cent carbon.

The practical conclusion to be drawn from the above is that if steel be used for standardising it should be treated in such a way as to destroy the hydrocarbons, that is, by solution in nitric acid and evaporation to dryness with hydrochloric acid, the residue then being further treated exactly like an iron ore.

Some points in the treatment of an iron ore for analysis may fitly be reserved for another communication.

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ON THE

USE OF LITMUS, ROSOLIC ACID, METHYL ORANGE, PHENACETOLIN, AND PHENOLPHTHALEIN AS INDICATORS.*

Part III.†

By ROBERT T. THOMSON.

The following notes are a further continuation of my former papers on the same subject:—

I. *Determination of Small Proportions of Hydrate in Prer sence of Large Quantities of the Carbonates and othe-Compounds of Sodium and Potassium.*

There are excellent processes for the determination of large proportions of hydrate in solutions which contain comparatively small quantities of the alkali metals, but in the converse case chemists are forced to fall back on methods which are open to serious objection. This state of matters can, however, be remedied by the use of a method which I have employed, and which is principally based on the neutrality of precipitated carbonate of barium to phenolphthalein, a fact which I had occasion to make known in the second part of this paper. The process consists in adding to the solution of the carbonate of sodium or potassium excess of chloride of barium solution which has been previously carefully neutralised, using phenolphthalein as indicator. A double decomposition thus occurs, carbonate of barium and chloride of sodium being produced, while the hydrate remains in solution. It is now only necessary to add a little more phenolphthalein, and titrate with standard acid, the number of c.c. consumed being calculated to hydrate of sodium or potassium, as the case may be. The whole process must be carried out *in the cold*, for reasons immediately to appear. It is clearly evident that the results will be quite as accurate whatever proportion the hydrate may bear to the carbonate, and the method would thus be useful on many occasions where the use of phenacetolin as indicator would be inadmissible, or at least would give very unsatisfactory determinations. To test the process 2 grammes of pure carbonate of sodium, prepared by igniting bicarbonate of sodium at a temperature just short of the fusion-point of the former salt, were dissolved in water, mixed with a quantity of standard caustic soda containing 0·02 grm. of pure hydrate of sodium. This mixture would represent a sample containing about 1 per cent of the hydrate. To the solution excess of chloride of barium was now added, and for three experiments 4·9, 5, and 5·1 c.c. of decinormal sulphuric acid (1 c.c. = 0·004 grm. NaHO) were consumed respectively. The average of these results is exactly 0·02 grm. of hydrate of sodium, which was the proportion added.

Similar results were obtained in the determination of hydrate of potassium under the same circumstnces as those just described.

In the second part of this paper I showed that precipitated carbonate of calcium was, when boiled, neutral to phenolphthalein, and experiments were therefore made in which chloride of calcium was employed to decompose the carbonate of sodium instead of chloride of barium, the titration being necessarily accomplished in a boiling solution, or at least after it had been boiled. It was found that in every case the amount of hydrate of sodium obtained was under the truth, and at the same time the results varied from each other to an appreciable extent. It would seem that some hydrate of calcium is formed, is entangled or combines with the precipitated carbonate of calcium, and thus remains insoluble.

When the sodium carbonate was decomposed by the barium salt, and the titration accomplished in a boiling solution, the results were likewise low, though not to so considerable an extent as when the calcium compound was employed. This then is the reason for carrying out the process, from beginning to end, in a cold solution.

Having now established the accuracy of the process when hydrate and carbonate only are being dealt with, the advisability of taking into account the limitations to which

* Read before the Chemical Section of the Glasgow Philosophical Society, February 11th, 1884.
† For Parts I. and II. see Chemical News, vol. xlviii., pp. 123 and 185.

it may be subject must not be overlooked. For this purpose it is necessary to discover the influence, if any, which would be exercised by the impurities often met with in commercial carbonates of sodium and potassium. It is evident that the chlorides of these metals cannot have any effect, as they are not decomposed by the barium chloride and are neutral. The sulphates and sulphites were tested after being precipitated with barium chloride, but the full amount of hydrate was obtained. If titrated directly, one-third of the base existing in the tribasic phosphate of sodium or potassium is determined by standard acid; but I found that the phosphate of barium precipitated was neutral to phenolphthalein, and that it did not interfere to any appreciable extent with the accuracy of the results. Half of the base existing as sulphide is estimated even after addition of the chloride of barium; but it was found that if a few drops of hydrogen peroxide is added, and the solution allowed to stand for a few minutes, the sulphide is completely converted into sulphate, and thus rendered harmless. The only other compounds likely to be present are the silicate and aluminate of sodium or potassium. In the case of the latter compound the whole of the soda or potash will be determined, while in the silicate it was found that although barium silicate was precipitated, about 90 per cent of the base was obtained, or exactly the proportion brought out by the direct titration of the alkaline silicate. The composition of the sodium silicate adopted is that of ordinary "soluble glass" ($Na_2Si_4O_9$).

The foregoing method can also be applied to the determination of hydrate of sodium or potassium in various other compounds which give precipitates with barium chloride neutral to phenolphthalein, such as the normal sulphites and phosphates of the alkali metals. The use of indicators may be shown from an analysis of sulphite of soda. Of course sulphate, thiosulphate, and chloride are determined as usual; but to estimate sulphite, carbonate, and hydrate or bicarbonate of sodium by methods in ordinary use is rather a tedious operation. To find the proportion of hydrate all that is now necessary is to precipitate with barium chloride, and titrate with standard acid as above described. Then, by simple titration of another portion of the sample in the cold, using phenolphthalein as indicator, the hydrate and half of the carbonate can be found; and finally, by employment of methyl orange as indicator, and further addition of acid, the other half of the carbonate and half of the sulphite of sodium can be estimated. By simple calculations the respective proportions of these two compounds can be obtained, a result which can be accomplished in a few minutes. It must be borne in mind that if a large quantity of carbonate of sodium is in the sample, the proportion of that compound found will only be an approximation to the truth, as the end-reaction is only delicate with small proportions of carbonate of sodium. If there is no hydrate found bicarbonate of sodium can be tested for and determined by the method to be described.

II. *Determination of Bicarbonate of Sodium or Potassium in presence of the Normal Carbonate.*

The method I would propose for this rests on the same basis as that which has just been under consideration. It consists in adding to the cold solution of the sample an excess of standard caustic soda, the strength of which has been accurately tested as regards sodium hydrate by the method described above; then adding barium chloride, and estimating the excess of hydrate of sodium employed by standard acid. This result is subtracted from the total caustic soda used, and the remainder, which has been consumed in converting the bicarbonate into normal carbonate of sodium or potassium, calculated to the first-mentioned of these salts. To put this process to the test 2 grms. of pure carbonate of sodium were mixed with 0·03 grm. of the bicarbonate, and the whole dissolved in cold water. To the mixture 5 c.c. of decinormal hydrate of sodium, then excess of chloride of barium, were added, and finally decinormal sulphuric acid, of which 1·4 c.c. were consumed in one experiment and 1·5 in another. This shows that in the first case 3·6, and in the second 3·5 c.c., of the decinormal alkali were consumed in neutralising the bicarbonate of sodium, the calculated results being equivalent to 0·03024 and 0·0294 grm. respectively. of that salt, in place of 0·03 grm. actually used.

Another test was made with 2 grms. of a sample which contained 88·6 per cent of bicarbonate of sodium. To the cold solution 25 c.c. of normal sodium hydrate were added, and, after precipitation with barium chloride, exactly 4 c.c. of normal acid were consumed. This represents 1·764 grms. of $NaHCO_3$ instead of 1·772 grms. really present.

As will be seen this method is a modification of that described by Lunge (*Journ. Soc. Chem. Industrie*, i., 57), the essential difference consisting in the use of phenolphthalein as indicator. By this means the time is saved which would otherwise be consumed in removing the carbonate of barium precipitate when the latter process is employed.

III. *The Arsenates of Sodium and Potassium, and Determination of Arsenic Acid in these Compounds.*

A series of experiments were made with normal arsenate of sodium (Na_3AsO_4) with the view of observing the behaviour of that salt with the five indicators before treated of, when titrated with standard sulphuric acid.

Arsenic acid was first prepared by oxidising 9·9 grms. of arsenious acid (As_2O_3) with nitric acid, and evaporating over a water-bath several times with addition of water, till all the nitric acid was expelled. The arsenic acid thus obtained was dissolved in water, 300 c.c. of normal caustic soda solution added, and the whole made up to 500 c.c. The caustic soda had been nearly entirely freed from carbonate by adding a slight excess of barium chloride, then removing the excess of barium salt by addition of sodium sulphate, allowing the precipitate to settle thoroughly, and syphoning off the clear fluid. For each test 50 c.c. of the arsenate solution were employed, and this quantity contained exactly 2·08 grms. of normal arsenate of sodium, which is equivalent to 0·93 grm. of soda (Na_2O) and 1·15 grms. of arsenic anhydride (As_2O_5). But to make sure that no arsenic had been lost by spirting or other means, during the oxidation and evaporation described, a determination was made by precipitation as ammonium magnesium arsenate, the weight of which showed that the solution contained the proportion of sodium arsenate stated.

Litmus.—When this indicator was employed 19·9 c.c. of normal acid were required to effect the neutralisation. After adding about two-thirds of the acid the blue colour had become purple, and onwards from that stage the blue was gradually discharged until the pure red only was observable. Owing to this gradual change in colour it is very difficult to detect the point at which the last trace of blue or purple is eliminated, and indeed this can only be done with any degree of accuracy by comparing the solution which is being titrated with an equal volume of water containing the same proportion of litmus reddened by an excess of acid.

Rosolic Acid acts in every way like litmus, the change in colour being very slow and the end-reaction very indistinct. To bring to the neutral point 19·85 c.c. of the normal sulphuric acid were required. This is equal to 0·614 of soda, or about two-thirds of that contained in the normal arsenate used, so that the mono-sodium salt (NaH_2AsO_4) may be said to be practically neutral to both rosolic acid and litmus.

Methyl Orange.—For two experiments made with methyl orange as indicator 20·0 and 20·05 c.c. were respectively consumed, the average of these being equal to 0·6207 grm. of soda, or almost exactly two-thirds of the soda present. Not the slightest change in colour was observed until the amount of acid quoted was added, and then only a slight tinge of pink was imparted to the yellow colour, so faint that without some practice it is almost impossible to detect

it without comparison with the same bulk of water coloured with a quantity of methyl orange equal to that which has been employed in the titrated solution. A few drops more of the standard acid brought out the full pink colour, so that this intensification of colour can be used in confirmation of the first result.

Phenacetolin acted in much the same manner as rosolic acid and litmus, the end-reaction being very ill-defined. To bring to the neutral point 19·9 c.c. of normal acid were consumed.

Phenolphthalein acts in an entirely different way to any of the other four indicators. It differs from litmus, rosolic acid, and phenacetolin in giving a well-defined end-reaction, and is also dissimilar to these and to methyl orange, in indicating the neutral point at a different stage of the process. In two experiments in cold solutions 10 c.c. were consumed for each, a result which is equivalent to one-third of the total soda. It is thus established that while the mono-sodium arsenate (NaH_2AsO_4) is neutral towards the four indicators just enumerated, the disodium salt (Na_2HAsO_4) is neutral to phenolphthalein. When used in a boiling solution the last-named indicator gives a sensibly higher result, as will be seen from the following table:—

TABLE I.

Results obtained in the titration of sodium arsenate.

Na_3AsO_4 used for each test .. 2·08 grms.
= Na_2O ,, ,, .. 0·93 grm.

Name of Indicator.	C.c of Normal Acid consumed.	Gramme of Na_2O found.
Litmus	19·9	0·6169
Rosolic acid..	19·85	0·6154
Methyl orange	20·0—20·05	0·6200—0·6215
Phenacetolin	19·9	0 6169
Phenolphthalein (cold)	10·0—10·0	0·3100—0·3100
,, (hot)	10·9—11·0	0·3379—0·3410

It is evident that, on the definite difference of indication shown by methyl orange and phenolphthalein, a process for the determination of arsenic acid in commercial arseniate of soda may be founded, as I formerly showed could be done for the acids of phosphate and sulphite of sodium. All that is necessary is to dissolve 2 or 3 grms. of the sample in water, filter if necessary, then add standard acid or alkali till the neutral point is reached with methyl orange. Now boil to expel carbonic acid, cool (if the solution is kept hot a low result will be the consequence), add a little phenolphthalein, and determine with normal or half-normal hydrate of sodium. One c.c. of normal alkali will be equal to 0·115 grm. As_2O_5. To make sure that carbonate of sodium did not interfere, which it would if all carbonic acid were not expelled as described, 50 c.c. of the sodium arsenate solution used for testing the indicators were measured off, 1 grm. carbonate of sodium added, and the experiment proceeded with. Of the normal caustic soda 10 c.c. were consumed, which is equal to 1·15 grm. of As_2O_5, or exactly the proportion present. The only substance in "arseniate of soda" likely to influence the accuracy of the method is arsenite of sodium or arsenious acid, which, as I shall show presently, would tend to give somewhat high results. I may state, however, that in several samples of commercial arseniate tested by myself, I have failed to detect arsenite.

Tests were also made with potassium arsenate, but it was found that it acted in every particular in precisely the same manner as the sodium compounds.

IV. *Arsenite of Sodium and Potassium.*

For the purpose of experiment 9·9 grms. of pure arsenious anhydride (As_2O_3) were dissolved in 100 c.c. of normal caustic soda freed from carbonate, and the whole made up to half a litre with water. For each test 50 c.c. were employed, and this quantity would contain 1·3 grms. of sodium arsenite ($NaAsO_2$) or 0·31 grm. of soda (Na_2O).

Litmus.—When this indicator was used 10 c.c. of normal acid were consumed, and, although the blue colour became purple towards the end of the experiment, the end-reaction was easily recognised. The amount of soda obtained was exactly that present.

Rosolic Acid behaved in much the same way as litmus, the colour changing slowly towards the end, but the end-reaction being distinct.

Methyl Orange.—With this indicator 10 c.c. were consumed in two experiments, which give exactly the amount of soda present. The end-reaction was quite as delicate as with carbonate of sodium, thus proving that arsenious acid is neutral to methyl orange.

Phenacetolin behaves like rosolic acid and litmus.

Phenolphthalein differs from the other indicators in showing the neutral point after the addition of 9·05 c.c. in one test and 9·1 in another. This was in a cold solution, but when boiled 8·9 and 9 c.c. were respectively required. The colour in this case also slowly changed towards the end.

TABLE II.

Results obtained in the titration of sodium arsenite.

$NaAsO_2$ used for each test .. 1·30 grms.
= Na_2O ,, ,, .. 0·31 grm.

Name of Indicator.	C.c. of Normal Acid consumed.	Gramme of Na_2O obtained.
Litmus	10	0·310
Rosolic acid..	10	0·310
Methyl orange	10—10	0·310—0·310
Phenacetolin	10	0·310
Phenolphthalein (cold)	9·05—9·1	0·2805—0·2821
,, (hot)	8·9—9·0	0·2759—0·2790

With arsenite of potassium similar results to those obtained with the sodium salt were brought out.

It will be observed that arsenious acid, although neutral to methyl orange, requires a considerable quantity of soda or potash to render it neutral to phenolphthalein, and it is for this reason the presence of an arsenite in arsenate of sodium would give the proportion of arsenic acid above the truth.

In conclusion I may state that I have made experiments with the view of basing a process for the determination of boric acid in borates, on the difference of indication shown by phenolphthalein and methyl orange. These have ended in failures, owing to the extremely indistinct end-reaction with the former indicator, even when small proportions of borate are operated upon.

City Analysts' Laboratory,
138, Bath Street, Glasgow.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 6, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

IT was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (March 20).

The following certificates were read for the first time:— G. C. Bose, J. P. Battershall, W. D. Crumbie, W. J. Grey, H. G. Greenish, J. H. Wainwright.

Dr. MILLER then read a paper entitled "*Studies on Sulphonic Acids; No. I., On the Hydrolysis of Sulphonic Acids, and on the Recovery of Benzenes from their Sulphonic Acids*," by H. E. ARMSTRONG and A. K. MILLER. The authors were led to investigate the behaviour of sulphonic acids on distillation with sulphuric acid, in the course of a study of the hydrocarbons resulting from the action of dehydrating agents upon camphor, their primary object being

the separation of the 1:2:3:5 tetra-methyl-benzene. It appeared, from various considerations, probable that this body would form a highly unstable sulphonic acid. It was found on passing steam into the sulphuric acid solution of the mixtures of hydrocarbons from camphor that all the benzenes could in this way be recovered. The method consists in passing steam through the solution of sulphonic acid or sulphonate in sulphuric acid, the acid solution being heated and maintained at the temperature at which hydrolysis takes place with fair rapidity. A weight of acid was usually employed equal to that of the sulphonate taken. Apparently no decomposition of any of the benzenes takes place, and the yield of hydrocarbon may be said to be theoretical. The authors give the following list of sulphonic acids used and the temperature of initial hydrolysis:—Benzen-sulphonic acid, 175°; toluen-para-sulphonic acid, 150°; meta-xylen-sulphonic acid, 120°; ortho-xylen-sulphonic acid, 120°; para-xylen-sulphonic acid, 120°; pseudo-cumene-sulphonic acid, 115°; mesitylen-sulphonic acid, 100°; cymen-sulphonic acid, 130°; 1:2:3:5 tetra-methyl-benzen-sulphonic acid, 120; meta-methyl-isopropyl-benzen-sulphonic acid, 120°; 1:2:4 dimethyl-ethyl-benzen-sulphonic acid, 120°. From their results the authors believe that it will be possible to separate many hydrocarbons by this "fractional hydrolysis" from mixtures of their sulphonic acids. The authors give some results in which the rate of hydrolysis at different temperatures has been studied. They are about to investigate the influence of pressure on the rate of hydrolysis.

Dr. Tilden asked if there appeared to be any relation between the composition of the sulphonic acids and the temperatures at which they were decomposed.

Dr. Armstrong said that sufficient data had not yet been obtained, but apparently the simpler the constitution the less readily did decomposition take place. He also mentioned that in many cases fractional distillation completely failed as a method for purifying hydrocarbons, principally because bodies belonging to different series, but having the same boiling-point, were often present in the same mixture. By the above method this difficulty might be overcome. The excess of hot strong sulphuric acid was also advantageous in carbonising some hydrocarbons present as impurities.

The Secretary then read a paper "*On a Relation between the Critical Temperatures of Bodies, and their Thermal Expansions as Liquids*," by T. E. Thorpe and A. W. Rücker. From Van der Waals's investigations it appears that the want of similarity between the formulæ which express the expansions of liquids is due to the fact that their initial-point is in general the arbitrarily-selected temperature of melting ice. Uniformity of mathematical expression can only be attained if, in each case, the temperature is expressed, not in ordinary thermometric degrees, but as a fraction of the absolute boiling-point of the substance. It is thus possible to obtain the law of the thermal expansion of any one liquid from that of any other, if their critical temperatures be known. Mendelejeff, in a paper recently read before the Chemical Society, gave an extremely simple and accurate empirical formula for the expansion of liquids. One of the conclusions at which Van der Waals arrives is that the product of the coefficient of expansion under constant pressure into the absolute critical temperature is, at corresponding temperatures, the same for all bodies. By combining these two formulæ the authors arrive at a formula which may be expressed in words as follows:—The density of a liquid is proportional to the number obtained by subtracting its absolute temperature from its absolute critical temperature, multiplied by a constant which is the same for all substances. The values of this constant, in the case of the substances for which the necessary experimental data exist, are almost identical, and approach very closely 2. Therefore the above expression can be further simplified thus. The density of a liquid is very nearly proportional to the number obtained by subtracting its absolute temperature from twice its absolute critical temperature. If further investigation proves that the range of variations in the above constant is small, the expression already given affords a ready and valuable means of calculating the critical temperatures of bodies from observations on their expansions as liquids.

Dr. Hugo Müller then took the chair while Dr. Perkin read a communication entitled "*Remarks on the Densities of Members of Homologous Series*." An investigation in which the author has been for some time engaged necessitated the determination of the densities of an extended series of carefully prepared products, especially the acids and ethers of the fatty series. On examining these results they exhibited a relationship to each other. The results were therefore plotted in curves, in which the numbers of carbon atoms were used as abscissæ and a scale of numbers, embracing those of the densities, as ordinates. The curves so obtained are regular, and the dots representing the experimental numbers are either on or close to the curves, and it is obvious from an inspection of the curves that the densities of the homologous acids and ethers follow a regular law.

Dr. Tilden remarked that there were singular irregularities as regards the physical properties—for instance, melting-points—in some of the homologous series.

Dr. Armstrong suggested that in the case of formic and acetic acids this might be explained by supposing that the influence of the hydrocarbon portion of the acid was small compared to that of the oxatylic portion; and, again, we had no evidence to prove that the formula of acetic acid was not more complicated than—

$$\left\{\begin{array}{l} CH_3 \\ COOH \end{array}\right.$$

If a formula could be calculated for Dr. Perkin's curves i might be most valuable in discriminating isomeric acids.

Dr. Perkin said that as regards magnetic rotation, formic and acetic acids seemed to be outside the fatty acid series, which seemed to commence with propionic acid.

Mr. Farrington then read a "*Note on some Experiments made at the Munster Agricultural School to Determine the Value of Ensilage as a Milk- and Butter-producing Food.*" Two cows were fed for a week upon ensilage and 5 lbs. of meal, and for a second week upon a mixed food of carrots, beet, hay, oats. The total quantity of milk obtained with the ensilage was 433½ lbs., giving 1 lb. of butter from 33 of milk; with the ordinary food, 414½ lbs. of milk, yielding 1 lb. of butter from 34·5 of milk were obtained. The butter from the ensilage was inferior in quality. The author states that 84 lbs. of ensilage replaced 25 lbs. of hay, and that the expense of making hay and its equivalent of ensilage was equal, but that the use of ensilage effected a saving for each cow daily of 2 stones of roots and ¼ bushel of grains. The total solids and cream in the milk were estimated.

In answer to some questions of Mr. Warington, the author stated that he was unable to give the basis upon which the equivalent quantities of hay and ensilage were calculated, and did not know whether the grass was compounded of the same materials (grass, vetches, &c.) as the ensilage.

The Secretary then read a "*Note on the Behaviour (1) of the Nitrogen of Coal during Destructive Distillation, and (2) a Comparison of the Amounts of Nitrogen left in Cokes of Various Origin*," by Watson Smith. Prof. Foster in a recent paper (*Chem. Soc. Jour. Trans.*, 1883, 110) states—"I have not made any experiments on the amount of nitrogen in tar, nor am I in possession oi any information on the subject. I have assumed that the quantity is relatively small." The author of the present paper has investigated the subject, having observed in 1868 that ammonia was frequently formed during the distillation of coal-tar. He has obtained the following numbers:—Nitrogen in the tar, 1·667 per cent; in crude benzene from the tar, 2·327; in "light oil," 2·186; in creosote oil, 2·005; in "red oil," 2·194: in the pitch,

1·595. The author has also estimated the amounts of nitrogen in three cokes—*a*, ordinary gas coke; *b*, Beehive metallurgical coke; *c*, a hard, compact, metallurgical coke from a Simon-Carvés oven. *a* contained 1·75 per cent, *b* 0.511 per cent, and *c* 0·384 per cent of nitrogen.

Mr. E. W. Voelcker said that in some experiments which he had recently made he had found that it was impossible to get rid of the whole of the nitrogen by carbonising such bodies as peat, charcoal, &c., even when very high temperatures were used. These results seemed to have an important bearing on the analysis of nitrogenous bodies by the soda-lime method. When manures from such substances as blood, fish guano, &c., were analysed, if any lumps formed the whole of the nitrogen could not be obtained.

Mr. Groves said that no statement was made as to where the coke came from, whether from the middle or sides of the ovens. The middle portion of the coke, being subjected to a much lower temperature than the coke at the sides, might be expected to contain more nitrogen.

"*On a hitherto unnoticed Constituent of Tobacco*," by T. J. Savery. Whilst examining some tobacco for sugar a substance was noticed in the aqueous solution which reduced Fehling's solution. This body was almost completely removed by clarification with sub-acetate of lead, and the resulting liquid was free from sugar. The author succeeded in isolating this reducing substance by precipitation with sub-acetate of lead, decomposition with sulphuretted hydrogen, &c. The substance gave a green colouration with ferric chloride, changing to red on the addition of potash. With ferrous sulphate alone no change was produced, but when this reagent was added with ammonia a dark brown colour appeared. A purer product from unmanufactured tobacco gave the same reactions, and developed a red colour with strong sulphuric acid, changing to a claret on the addition of a trace of nitric acid. A green colour was produced with either potash or ammonia. The substance precipitated hydrochlorides of quinin and cinchonin. The author concludes that the body is closely allied to caffetannic acid, and names it Tabaco-tannic acid. No analyses are given.

The Society then adjourned to March 20, when a ballot for the election of Fellows will be held, and a "Note on the Preparation of Marsh-Gas," by Dr. Gladstone and Mr. Tribe, will be read.

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, March 8, 1884.

Prof. F. Guthrie, President, in the Chair.

Lord Rayleigh read a paper "*On the Electro-Chemical Equivalent of Silver.*" The determination was made by a method described to the last meeting of the British Association at Southampton, which consists in using two fixed coils and a movable coil suspended between these from one end of a balanced beam. These coils are in circuit with the current and voltameter. The current is reversed in the fixed coils at intervals of five minutes, and the weight required to bring the balance even is noted. The calculation of the effect by this method is independent of the precise measurement of the coils. Two or more silver voltameters were in circuit, nitrate of silver being the solution used. Careful precautions of various kinds were taken, and the result was that unit C.G.S. current deposits $1{\cdot}118 \times 10^{-2}$. It follows that 1 ampere will deposit 4·025 grammes of silver per hour.

Lord Rayleigh also read a paper "*On the Absolute Electromotive Force of Clark's Cell.*" Experiments made at the Cavendish Laboratory gave the electromotive force of this cell as 1·453 volts. The accepted value is 1·457 volts. If the B.A. unit (as Lord Rayleigh believes) is about 0·9867 of a true ohm, the result 1·453 becomes 1·434 volts.

Lord Rayleigh also mentioned that he had been making experiments on the rotation of the plane of polarised light in bisulphide of carbon, and obtained a result agreeing more nearly with Gordon's than Becquerel's.

Profs. Guthrie and Ayrton spoke on the papers, the former eliciting the reply that electro-corrosion was less satisfactory than electro-deposition for determining the equivalent; and the latter that silver was better than copper for accurate results in the voltameter.

Mr. Shelford Bidwell, M.A., read a paper "*On some Experiments Illustrating an Explanation of Hall's Phenomenon.*" By these experiments Mr. Bidwell sought to explain Hall's effect through a combination of mechanical stress and the well-known Peltier effect, on the thin metal plate which is placed between the poles of the magnet. He repeated many of the experiments, and showed how he had obtained the same results as Hall, except in the case of aluminium, which he found to be 1+, like iron, whereas Hall made it −. Mr. Bidwell reversed the effect by cutting two slits in the strip of metal, thereby altering the stress on it. Righi's effect was also explained on the same grounds.

Mr. Walter Browne said that difference in the quality of the aluminium might explain the anomaly with this metal.

Prof. Perry criticised the explanation of the slitted plate, and Prof. G. C Foster suggested that results in absolute measure should be got.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, March 3rd, 1884.

Sir Frederick Pollock, Bart., M.A., Manager and Vice-President, in the Chair.

The following were elected Members of the Royal Institution:—Major-Gen. W. H. Beynon, F. W. Blunt, J. G. Bristow, M.A., Mrs. R. Brudenell Carter, Mrs. J. T. Clover, F. M. Gowan, W. Hooper, J. C. Medd, R. Muir, B. M. Power, Mrs. William Crookes, P. Donovan, J.P., L. H. Edmunds, B.A., Miss J. L. Reynolds, S. H. Salt, G. N. Strawbridge, F.Z.S.

Three Candidates for Membership were proposed for election.

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Chemical Section.

January 23rd, 1884.

Mr. J. J. Coleman read a paper describing experiments he had made on the heat-conducting power of substances available for the insulating walls of ice-houses and other purposes of a similar character.

Tin boxes, of about 1 cubic foot capacity, were placed inside tin boxes of larger capacity, so as to allow of a uniform space of 4 inches wide between the outer surface of the inner box and the inside of the outer box, which space was filled with the material to be tested. A number of such boxes were arranged in a room kept by a stove at a uniform temperature of 60° Fahrenheit, and a similar number in a room of 100° F. temperature, the ice melted in twenty-four hours being from time to time drawn off and measured after the principle of the Lavoisier calorimeter. The first series of experiments in a room of 60° F. gave the following figures as the conducting power for heat, viz.:—

1. Silicate cotton	100
2. Hair felt	117
3. Wood charcoal	120
4. Wood shavings	125
5. Gas works breeze (coke dust)	230
6. Air spaces of 1 in. alternated with wood 1 in...	280

A second set of experiments in a room of 100° F. gave as follows:—

1. Silicate cotton	100
2. Cotton wool	122
3. Sheeps' wool	136
4. Infusorial earth	136
5. Wood charcoal	160
6. Sawdust	163

In this room the quantity of ice melted per square foot of superficies per twenty-four hours was about 1 pound avoirdupois for an insulation of charcoal 4 ins. thick.

Mr. Coleman also exhibited a Discontinuous Thermoscope, or Thermometer, he had invented, composed of a number of tube bottles arranged in a row in a wooden frame, the liquid contents of which became frozen successively as the temperature lowered, commencing with an olefine (paraffin) solidifying at 100° F., the series consisting of olefines until 32° is reached, when the series is continued to 40° below zero with mixtures of glycerin and water.

At the meeting held on February 23rd the triennial "Graham Lecture" was communicated to the Society by R. Angus Smith, LL.D., F.R.S., and consisted chiefly of extracts from unpublished private letters of Thomas Graham to members of his family and friends, which were of a most interesting character, and are to form the basis of a memoir to be published together with a synopsis of Graham's work.

CORRESPONDENCE.

CHLOROPHYLL.

To the Editor of the Chemical News.

Sir,—In the *Journal of the Chemical Society* for February is an interesting paper by Dr. A. Tschirch on the "Preparation of Pure Chlorophyll," in which he lays claim to the discovery that chlorophyll can be generated from the oxidised product (chlorophyllan—acid chlorophyll) by the action of zinc-dust on the alcoholic solution at the heat of the water-bath. From the spectroscopic and other characters he says:—"I regard this pure chlorophyll as identical with the chlorophyll of living plants, and reserve to myself the right of examining it further."—*Trans.*, vol. xlv., p. 60.

If Dr. Tschirch will turn to the Chemical News, vol. xxxviii., p. 168, he will find a "Note on Chlorophyll" by Mr. A. H. Church, in which the above-mentioned process for obtaining that body from chlorophyllan by the action of zinc-dust at the temperature of the steam-oven, is described. I do not know whether Mr. Church is continuing his investigation of the green colouring matter of leaves, but evidently, in face of the above anticipation, Dr. Tschirch cannot reserve to himself the *right* of examining this substance to the exclusion of other observers.—I am, &c.,

R. W. Atkinson.

44, Loudoun Square, Cardiff,
March 6, 1884.

SCIENTIFIC BIGOTRY.

To the Editor of the Chemical News.

Sir,—My friend Prof. Charles A. Joy, lately of Columbia College, New York, and temporarily residing in Tours, France, has sent me by mail a copy of a lecture on Organic Chemistry which deserves to be regarded as a veritable literary curiosity. The lecture in question was delivered as an inaugural discourse at the opening of the School of Medicine and Pharmacy at Tours, on the 29th of November, 1883, by E. Grandin, Professor of Chemistry and Toxicology. The lecture is entitled "La chimie organique moderne," and was published in three issues of the local newspaper *L'Union Liberale* in December, 1883.

The author of this lecture treats of the growth and development of modern organic chemistry and accomplishes the extraordinary feat of wholly ignoring German contributions to chemistry. With a single exception not a German chemist is named throughout the entire lecture, the exception being a casual reference to Bunsen in connection with cacodyle. Sweden, England, Belgium, Italy are fairly represented, but Germany is a *terra incognita.* The credit of accomplishing the first synthesis of organic bodies naturally occurring in the vegetable and animal worlds is given to M. Berthelot. Germany is indeed mentioned, but only in this wise:—"La théorie atomique est enseignée maintenant à peu près partout, en Allemagne, en Angleterre, en Italie, en France, ou elle est brillamment représentée par MM. Kekulé, Odling, Cannizaro, et Wurtz." In this sentence Kekulé is made to serve as the representative chemist of Germany!

One looks in vain for the names of Liebig, Wöhler, Hofmann, Kolbe, Baeyer, and the rest.

Professor Grandin needs to be reminded of that notable saying of Sir Humphry Davy—"Science, like that nature to which it belongs, is neither limited by time nor space; it belongs to the world, and is of no country and of no age."—(Davy's speech as President of the Royal Society when presenting the Copley Medal to François Arago).

It is to be hoped that the bigotry exhibited in this lecture is confined to very few teachers in France; should it be otherwise, alas! for the future of chemistry in *la belle France.*—I am, &c.,

H. Carrington Bolton.

Trinity College, Hartford, U.S.A.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherw is expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 1, January 7, 1884.

Action exerted upon Polarised Light by Solutions of Cellulose in Schweitzer's Reagent.—A. Levallois.—All these solutions deflect the plane of polarisation strongly to the left. The tint of Schweitzer's solution is reduced when it is charged with cellulose.

The Combination-heat of Soluble Fluorides and the Law of Thermic Substitution-Constants.—D. Tommasi.—The calories of combination given recently by M. Guntz for certain fluorides are identical with those predicted in accordance with the author's law of thermic constants.

New Sulpho-salts derived from Phosphorus Trisulphide.—G. Lemoine.—The author had formerly obtained from phosphorus sesqui-sulphide, certain salts, the sulphoxy-phosphites, which may be considered as derivatives of a sulphuretted phosphorus acid, $POS_{2n}HO$. Analogous compounds may be obtained in a more direct manner from phosphorus trisulphide, which, under the influence of water tends to form phosphorous acid and hydrogen sulphide. By the action of soda in different proportions and by that of ammonium hydrosulphide, the author has obtained a series of compounds for which no names are proposed.

No. 2, January 14, 1884.

Formation-heat of the Fluorides.—M. Berthelot.—The author maintains that M. Tommasi has contributed nothing either to the especial question of the fluorides or

to the general question of thermic constants. He has made no experiments, and as to prevision he has confined himself to appropriate literally laws known thirty years ago, the law of Andrews and the law of Favre and Silbermann.

Generalisation and Rigorously Mechanical Demonstration of the Formula of Joule.—A. Ledieu.—A mathematical paper, not capable of useful abstraction.

New Method of Determining the Magnetic Declination with the Induction Compass.—M. Wild.—The author describes his process at length with the view of showing that it has a real advantage as compared with the old method.

Observation of Telluric Currents.—M. Larroque.—The intensity of the earth-current undergoes secondary fluctuations depending on the degree of moisture and on the temperature of the portion of earth which enters into the circuit.

Determination of the Combustion-heat of Certain Acetones and of Two Ethers of Carbonic Acid.—W. Longuinine.—For diethyl-ketone the mean heat evolved is 8569 cals. per grm. of the substance burnt, and for 1 mol. in grms. 736,934 cals. For dipropyl-ketone the mean values are 9244·5 cals. per grm. and 1,053,873 per mol.; for di-iso-propyl-ketone, 9172·4 cals. per grm. and 1,045,654 cals. per mol.; for methyl-hexyl-ketone, 9467·1 cals. per grm. and 1,211,789 cals. per mol. Hence there is a confirmation of the general rule that isomers of the same chemical function liberate in their combustion approximately the same quantities of heat. Methyl-carbonic ether gives 3774·34 cals. per grm. and 339,691 cals. per mol. Ethyl-carbonic ether gives 5442·8 cals. per grm. and 642,250 per mol.

The Phenomena of Dissociation.—M. Isambert.—A mathematical paper, not suitable for abridgment.

Preparation of Pure Chromium Sesqui-sulphate.—H. Baubigny.—The author takes as his starting-point a hydrate, obtained by treating purified potassium bichromate with a current of sulphuretted hydrogen, applying heat, or boiling after the treatment. The hydrate is first washed in the cold, and is then suspended in boiling water, fresh portions of which are applied until the filtrate no longer blackens a few drops of silver nitrate. Traces of alkali may be detected, if present, by igniting in the oxidising atmosphere of a muffle, and moistening the cold residue with a little pure dilute nitric acid. The presence of alkali is shown by the yellow tint of the liquid.

The Density of Liquid Oxygen.—M. Menge.—The author criticises the method of M. Wroblewski (*Comptes Rendus*, July 16, 1883), and contends that the exact specific gravity of liquid oxygen has still to be determined.

Ferric Ethylate and Colloidal Ferric Hydrate.—E. Grimaux.—If a molecule of ferric chloride dissolved in absolute alcohol is allowed to react upon 6 mols. of sodium ethylate, there is formed at once a precipitate of sodium chloride and a deep brown limpid solution of ferric ethylate, containing all the iron. If this solution is poured into an excess of water, there is obtained a clear liquid presenting the characters of the solutions of colloidal ferric hydrate described by Graham.

A Silicated Manganese Chloride.—A. Gorgeu.—If a current of hydrogen saturated with watery vapour is allowed to act at a cherry-red heat upon a mixture of 20 grms. pure manganese chloride and 1 grm. precipitated silica, there are obtained rhodonite, tephroite, and a silicated chloride.

The Influence of "Plastering" upon the Composition and the Chemical Characters of Wine.—L. Magnier de la Source.—The author fermented two equal and homogeneous portions of one and the same kind of grape, adding to the one 100 grms. pure calcium sulphate, and leaving the other without any addition. He found the alcohol and the grape-sugar in the two portions approximately identical. The total solids were increased by plastering from 23·30 to 27·30 grms.; the cream of tartar was entirely removed, the total acidity considerably increased, and especially the sulphuric acid. Plastering decomposes, not merely the potassium bitartrate, but also the neutral organic compounds of potassium, which exist in ripe grapes in a very notable proportion.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, Vol. 16, No. 8.

Further Observations on the Behaviour of the Carbon Thio-bromides.—C. Hell and Fr. Urech.—Further researches on carbo-trithio-hexa-bromide and CS_2Br_4.

The Imines.—A. Ladenburg.—Not adapted for abridgment.

Peptone.—A. Pœhl.—In this extensive memoir the author shows that the conversion of albumen into peptone is not accompanied by any change in its optical rotatory power, nor by any chemical change in the albumen molecule. He holds that the transformation depends on a gelatinising process analogous to those which we observe in hydrated silicic acid.

Different Modifications of Silver Bromide and Chloride.—H. W. Vogel.—This important paper cannot be usefully abstracted without the accompanying diagrams.

Certain Constituents of the Distillate of Wine.—S. Kiticsán.—In all the samples examined, ammonia has been found to an extent admitting of quantitative determination. Formic acid is frequently but not invariably present. Wartha's method for the detection of sulphurous acid in wine is not trustworthy, as silver nitrate gives a precipitate in wines which are absolutely free from sulphurous acid.

Mono-sulpho-pyridic Acid.—O. Fischer and C. Riemerschmid.—An account of the properties of this acid, of β-pyridine-dibromide, and of its platinum salt. The ease with which the sulpho-group of sulpho-pyridic acid is displaced by bromine is remarkable.

A Correction.—R. Andreasch.—The author points out an error in a former paper.

The Ptomaines.—L. Brieger.—The author holds that the physiological action of organic substances depends, not merely on their chemical constitution, but more or less on the number of the atoms of carbon present in the molecule.

Basic Products of Putrefaction.—E. and H. Salkowski.—The author gives for these bases the general formula $C_n H_{2n+1}NO_2$.

Decomposition of Water by the Non-metallic Elements.—C. Z. Cross and A. F. Higgin.—The authors prove experimentally that water at a boiling heat is decomposed by sulphur. Arsenic behaves in a similar manner, with the formation of arsenic hydride and arsenious acid.

The Reaction of the Acid Amides upon the Aromatic Amine Bases.—W. Kelbe.—The author finds that the acid amides if heated with aromatic bases form acid anilides.

The Behaviour of Nascent Hydrogen with Oxygen Gas.—Moritz Traube.—The author concludes that palladium hydride does not yield nascent hydrogen, that nascent hydrogen does not activate oxygen, and living tissues do not evolve hydrogen. The activating action of palladium hydride depends on the formation of hydrogen peroxide.

Journal de Pharmacie et de Chemie. Tome ix., February, 1884.

The State of Arsenic in Mineral Waters.—J. Lefort.—In the bicarbonic, sulphuric, and chloridic waters

arsenic is present in its highest stage of oxidation. In the waters containing hydrogen sulphide it is present as arsenious acid.

Analysis of the Red Spring of Zacaune (Tarn).—MM. Soubeiran and Massol.—This water presents no feature of chemical interest.

Examination of Certain Extracts of Cinchona, Belladonna, &c.—M. Lepage.—The author finds these extracts inferior to the officinal standard, and advises pharmacists either to prepare their own extracts, or to submit the samples obtained to a thorough examination.

Formation of Acetylene at the Expense of Iodoform.—P. Cazeneuve.—Already noticed.

New Researches on the Watering of Milk.—Dr. Sambuc.—For detecting the adulteration of milk with water the author, after pointing out the fallacious character of the results obtained with the lacto-densimeter, proceeds as follows:—Heat the milk to from 40° to 50°; add per 150 c.c. 2 c.c. of an alcoholic solution of tartaric acid prepared with alcohol at 85 per cent, and having the specific gravity 1·030 to 1·032. Remove from the fire, and stir with a small broom of osiers, upon which there forms a spongy clot, which entangles the butter. Strain through fine linen, pour the serum into a test-glass, and let it cool. When the temperature has fallen to 15° take its density with any sensitive hydrometer. The lowest specific gravity of the serum of genuine milk is 1·027.

Detection of Tartar Emetic in Syrup of Ipecacuanha.—M. Yvon.—The author takes 5 to 6 c.c. of the sample, adds 5 to 6 drops of hydrochloric acid, dilutes with an equal volume of water, and adds a few drops of a saturated solution of potassium iodide. If tartar emetic is present there is formed immediately a yellow precipitate of antimony iodide.

Artificial Wine.—M. Yvon.—An "industrial" is circulating the following receipt:—In a cask of 114 litres put 8 to 10 kilos. dry raisins, 10 to 14 kilos. glucose stirred up in a little water, and 1 litre of vinegar; add 1 litre of "*odorous mixture*," and 400 grms. of beer yeast. Fill up the cask with water including 6 to 8 litres boiling water, so as to raise the whole to the proper heat for fermentation. When this process is complete, colour it as desired with the accompanying "*powder*." This powder consists of magenta tailings (!), whilst the odorous mixture is a solution of tannin and tartaric acid in water flavoured with an artificial essence.

The Weight of Drops.—M. Boymond.—A paper of purely pharmaceutical interest.

Cholera, Typhoid, and Splenic Fever among the Copper-smiths of Willedieu.—M. Rochefontaine.—The author shows that, contrary to the opinion of M. Burq, copper affords no protection against zymotic diseases.

Action of Bromine on Pilocarpine.—M. Chastaing.—Already noticed.

The Artificial Production of Crystals of Gypsum.—A. Lacroix.—The author describes in detail the method by which he has obtained these crystals.

The Fusibility of the Nitrates.—M. Maumené.—From the *Comptes Rendus*.

The Artificial Production of Manganiferous Garnet.—A. Gorgeu.—From the *Comptes Rendus*.

Accidental Formation of Crystals of Cerusite on Roman Coins.—A. Lacroix.—The coins in question were composed of an alloy of copper with lead and a little tin. Some of them were coated with crystals of cerusite accompanied by a few cubes of cuprite, whilst others were encrusted with azurite, malachite, or cuprite.

Royal Institution.—Mr. Matthew Arnold will probably give a discourse on "Emerson" on Friday Evening, March 21, instead of Mr. Walter Besant, who will give his discourse on "The Art of Fiction" after Easter.

MISCELLANEOUS.

The Technological Museum, Sydney.—A superb collection of slabs of Continental Marbles was yesterday (Jan. 25) added to the Technological Museum. The slabs are uniformly 20 inches square and 1 inch thick, and are polished on one face, and on this a short description of them are to be found, the letters being cut into the slabs and gilt, producing a fine effect. These marbles are from the most celebrated quarries in Germany, Austria, Italy, France, and Belgium, and all the specimens are so handsome that it is difficult to particularise. It is proposed to line the pillars and to inlay a portion of the walls of the Museum with them. The collection of 6-inch cubes of building stones already in the Museum has also been supplemented by a number of cubes of limestone, sandstone, granite, lava, &c., from various localities in Europe. Several of these stones have been employed in the construction of the world-renowned Cathedral of Cologne, which has taken six centuries to complete. Mechanical engineers and others will be interested to learn that during the present week the walls, pillars, &c., of the Museum have been adorned with over 40 large framed photographs of machinery constructed by Messrs. Robert Daglish & Co., of St. Helens, Lancashire. Much of this machinery has been specially constructed for Colonial requirements, and includes stamper batteries, amalgamators, and miscellaneous gold mining machinery, copper ore mining machinery, appliances used in grinding, smoothing, and polishing plate-glass, miscellaneous chemical plant, including complete machinery for the manufacture of soda from sea-salt, steam cranes, hoists, &c., large boilers, blowing, winding, pumping engines, &c. A complete series of coloured maps and plans to illustrate the geology of Belgium has just been received from the Royal Museum at Brussels, and will be displayed in the course of the next few days.—*Sydney Morning Herald*, Jan 26.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Estimation of Ferrous and Ferric Oxide.—I want to estimate FeO and Fe_2O_3 in some serpentines. I conclude this HF method is the best. Is not Oudeman's method ($Na_2S_2O_3+CuSO_4+KCNS$) more expeditious than $K_2Cr_2O_7$?—A. P. S.

MEETINGS FOR THE WEEK

Monday, Mar. 17th.—Medical, 8.30.
— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S,
Tuesday, 18th.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
— Society of Arts, 8. "Borneo," by B. Francis Cobb.
Wednesday, 19th.—Society of Arts, 8. "The Elephant in Freedom and Captivity," by G. P. Sanderson.
— Meteorological, 7.
— Geological, 8.
Thursday, 20th.—Royal, 4.30.
— Philosophical Club, 6.30
— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
— Chemical, 8. Ballot for the Election of Fellows. "Note on the Preparation of Marsh-Gas," by Dr. Gladstone, F.R.S., and A. Tribe. "On the Action of Dibrom-α-Naphthol upon Amines," by R. Meldola.
Friday, 21st.—Royal Institution, 8. "Emerson," by Mr. Matthew Arnold, at 9.
Saturday, 22nd.—Royal Institution, 3. "Photographic Action," by Capt. Abney.
— Physical, 3. "On Hall's Phenomena," by Prof. S. P. Thompson, D.Sc., and Colman C. Starling, and also by H. Tomlinson; "On some Propositions in Electro-magnetics," by Prof. S. P. Thompson, D.Sc., and W. M. Moorsom.

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ON A

CONVENIENT MODIFICATION OF McLEOD'S METHOD FOR THE FORMATION OF CUPROUS ACETYLIDE.

By G. STILLINGFLEET JOHNSON, King's College, London.

Having been in the habit of preparing cuprous acetylide for Professor Bloxam for some years past by McLeod's method, *i.e.*, by passing the products of combustion of air in coal-gas into an ammoniacal solution of cuprous hydrate obtained by adding excess of ammonia to a solution of cuprous chloride in hydrochloric acid, it always appeared to me that the most troublesome and unsatisfactory part of the process was the production of the cuprous chloride, and the large amount of cuprous chloride converted into cupric hydrate, instead of into cuprous acetylide, after the addition of the ammonia to the cuprous solution.

To avoid these difficulties, Professor Bloxam suggested to produce an ammoniacal solution of cuprous hydrate by the reducing action of glucose upon ammoniacal cupric sulphate. Acting upon this suggestion, I now employ the following apparatus which is simple, economical and easily worked.

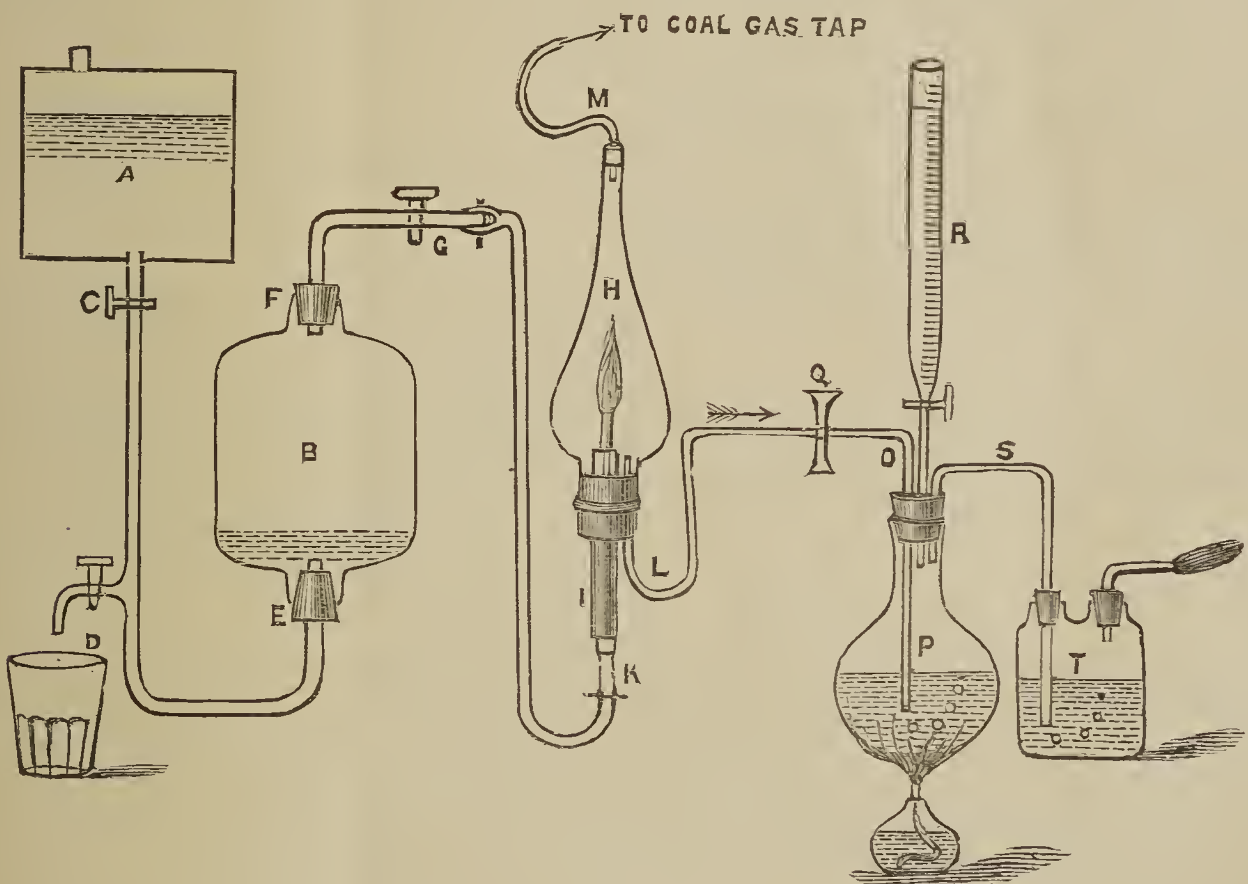
The stream of air is produced by the pressure of water in the metal reservoir, A, upon the air in the glass gas-holder, B. Now, as this part of the apparatus has been found, not only by myself, but also by many others in King's College, an extremely useful arrangement for storing gases over water without danger of contamination with the gases of the atmosphere, I will first describe the manner in which it is worked.

Suppose the reservoir A to be full of water, B to be full of air, and the taps, C, D, and G, all closed. It is desired to fill B with a certain gas, *e.g.*, oxygen. The taps G and C are opened, when the water contained in A flows into B, displacing the air it contained through the tap G. As soon as B is full of water, the tap C is closed. Now, on connecting G with the apparatus containing or evolving oxygen gas, and opening the tap D, the water in B flows out through D, whilst oxygen is drawn into the gas-holder, B, by a kind of aspiration. When B is full, the taps D and G are closed, and so long as C is also closed, there is no possibility of communication of the gas in B with the atmosphere. By opening C, we subject the gas in B to the pressure of the water in A, by which pressure it may be expelled with whatever rapidity we wish through the tap G. In my apparatus the gas-holder, B, is capable of holding about 12 litres of gas.

The special advantage of this apparatus for supplying the air to be burnt in coal-gas is the ease with which the rapidity of the current of air may be regulated by means of the tap, G, since oscillations of pressure are very apt to extinguish the flame.

The second part of the apparatus, in which the acetylene is produced, is figured and described in Professor Bloxam's work, "Chemistry: Inorganic and Organic, with Experiments"; 5th Edition, p. 93. I will quote his description of the diagram:—

"An adapter (H) is connected at its narrow end with the pipe (M) supplying coal-gas. The wider opening is closed by a bung with two holes, one of which receives a piece of brass tube (I) about 3 quarters of an inch wide and 7 inches long, and in the other is inserted a glass tube (L), which conducts the gas to the absorbing apparatus. The lower opening of the brass tube (I) is closed with a cork, through which passes the glass tube (K), connected with a gas-holder containing atmospheric air."



The air in H being expelled by coal-gas, which is ignited at the orifice of the brass tube, I, the tube, K, delivering air from the gas-holder, B, is thrust up through the tube I into H, where the jet of air remains burning in the coal-gas.

It now only remains to describe the *Absorbing Apparatus* intended to fix the acetylene as cuprous acetylide.

The tube, L, is now delivering coal-gas, charged more or

less with acetylene, one of the products of the combustion going on in H. This tube, L, is connected by rubber tubing with another glass tube, O, passing nearly to the bottom of the flask, P, through one of three holes in its cork. A strong screw clip, Q, closes the connector on O from the atmosphere. The flask, P, contains at first a strongly ammoniacal solution of cupric sulphate. The clip, Q, being closed, the contents of the flask, P, are raised to the boiling-point, the ammonia evolved being absorbed by water in the bottle, T, into which it is conducted by the tube, S, provided with a Bunsen's valve with a *longitudinal* slit, to prevent regurgitation. When the ammoniacal cupric solution quite boils, a solution of glucose is dropped in from the burette, R, and the boiling continued, till the solution is quite colourless. The clip, Q, is then opened, and the connector slipped on to L, when the coal-gas and acetylene enter the flask, and the cuprous acetylide is precipitated as usual.

Should any air accidentally enter the flask, P, at any time before the copper is completely converted into acetylide, the clip, Q, may be again closed, the contents of the flask once more boiled (with addition of more glucose from the burette if necessary) and the blue cupric hydrate again reduced to the cuprous condition, after which Q is opened and the acetylene allowed to enter as before.

If the pressure of the coal-gas be insufficient to force it through the Bunsen's valve, the tube S may be removed, and a simple glass tube, bent once at right angles, substituted, at the orifice of which the escaping gas may be burned.

By the adoption of the above method, the necessity for first making a quantity of cuprous chloride is quite obviated, and the *whole of the copper* introduced into the flask, P, may, with certainty, be converted into cuprous acetylide without the trouble of removing it, introducing fresh charges, &c.; the reduction of any cupric hydrate accidentally produced being readily effected, as I have described, without disturbing the apparatus in any way.

March 9th, 1884.

RESEARCHES IN SPECTRUM PHOTOGRAPHY IN RELATION TO NEW METHODS OF QUANTITATIVE CHEMICAL ANALYSIS.*

Part II.

By W. N. HARTLEY, F.R.S.E., &c.,
Professor of Chemistry, Royal College of Science, Dublin.

This paper includes an introduction recording the methods which have been proposed by different authors for the quantitative estimation of various metallic elements. An account is then given of the length and strength of metallic lines in solutions of definite strength. Under given conditions each solution emits a characteristic spectrum. In the case of magnesium, a minute description is given of the spectra presented by various solutions containing from 1 per cent to 0·0000001 per cent of the metal, but in the case of other elements tabular descriptions of the spectra of solutions containing 1, 0·1, and 0·01, in some instances 0·001, of metal are given, together with carefully drawn maps. The substances thus treated of are magnesium, zinc, cadmium, aluminium, indium, thallium, copper, silver, mercury, tin, lead, tellurium, arsenic, antimony, and bismuth.

The sensitiveness of the spectrum reaction is practically unlimited when applied to magnesium compounds dissolved in water, since it was shown that with a given length of spark $\frac{1}{1000000}$ of a milligrm. could easily be detected; when, however, the strength of spark was greatly increased, but the striking distance between the electrodes left unaltered, the sensitiveness was increased ten thousand-fold. In point of fact, one part of magnesium was detected in 10,000,000,000 parts of water, the lines seen under these circumstances being those with wave-lengths 2801·6 and 2794·1. The spectrum reaction of arsenic is the weakest, those of antimony and tellurium are also weak, while that of bismuth is not strong. In fact it is noticeable that the more strongly basic elements are those with the most persistent lines.

Evidence is afforded in the case of the aluminium spectrum that it is not invariably the longest or strongest line which is the most persistent. The line with wave-length 3584·4 is both longer and stronger than a pair of lines adjacent thereto with wave-lengths 3612·4 and 3601·1, but whereas the first is not seen in solutions containing 0·1 per cent of aluminium, the pair are still visible in solutions containing 0·01 per cent. Under certain conditions this single line appears the longest in the whole spectrum, whereas otherwise, and under most circumstances, the lines with wave-lengths 3960·9 and 3943·4 are longest.

As a rule, even the longest lines are shortened by great dilution of the solutions, but there is a pair of lines in the spectrum of copper with wave-lengths 3273·2 and 3246·9 which become greatly attenuated, yet nevertheless remain long lines till they finally disappear.

It is shown by one or two examples how the tables of spectra and accompanying maps may be employed in rendering quantitative results. The special applications of this method it is proposed to describe in a further communication.

* Abstract of a Paper read before the Royal Society, March 13, 1884.

ON THE PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

By a mode of investigation I have been recently adopting through which information is furnished of the precise nature of a carbohydrate existing in a product, I have been able to recognise and follow changes which have hitherto escaped observation, and have thus been afforded the opportunity of acquiring new knowledge regarding the physiology of the carbohydrates in the animal system.

In an "Introductory Note" presented to the Roya Society in April last (*Proc. Roy. Soc.*, vol. 35, pp. 145 to 147) I gave a summarised representation of the main points that had been disclosed, and stated that I proposed to deal with the subject in detail in a series of communications.

In this communication, which constitutes the first contribution, I purpose dealing with the changes undergone by the carbohydrates in their progress after ingestion into the portal blood. When I first became aware of the significance of the information which was being revealed by the method of investigation I was pursuing, I was working at the changes occurring within the system, and more especially in connexion with the liver; but seeing that the matter was presenting itself under a perfectly new light, it appeared to me advisable that the investigation should be carried to the commencing point at which the carbohydrates come into relation with the animal system, viz., the alimentary canal. I therefore started upon a systematic inquiry into the changes undergone by the four chief carbohydrates of our food—grape sugar, cane sugar, lactin, and starch—in their passage towards absorption and arrival within the portal system of vessels. This inquiry has resulted, not only in new knowledge being supplied, but in confirmation being given to the knowledge that had been acquired regarding the phenomena occurring in other parts of the system. By thus beginning with the study of the phenomena at the starting point, or the point where the carbohydrates first come into relation with the animal system, important help has been afforded, and al

* A Paper read before the Royal Society, Dec. 20th, 1883.

the information obtained stands in harmony, the one part with another, and conspires to show that the changes occurring in the principles belonging to the carbohydrate group proceed exactly in the reverse direction of that which has been generally supposed.

The means by which the truths to be adduced have been disclosed have consisted in the employment of extended measures for discriminating the precise nature of a carbohydrate having to be dealt with, and the application of the method of quantitative determination with the ammoniated cupric test which I introduced a few years ago (*Proc. Roy. Soc.*, vol. 28, pp. 260 and 520). Without the aid of this test I am quite satisfied I could not have attained the knowledge that has been acquired. One step has led on to another, and it has been by a gradual process that the matter as it has now to be put forward has been evolved. If the original information obtained had not been before me I should have had nothing to suggest the course of investigation that followed.

The process of differentiation adopted has been based upon the employment of alcohol, and the determination of the cupric oxide reducing power of the body before and after treatment by boiling with sulphuric acid for conversion into glucose.

By the employment of alcohol, starch and its animal congener, the so-called glycogen, are separable from the dextrins, maltose, and the sugars.

Methylated spirit is what I have used, and it has invariably been submitted to distillation, to secure freedom from chance contamination that might vitiate the result. Actual experience has taught me the necessity of giving attention to this point. The specific gravity of the spirit has stood at about 0·803, which corresponds with the strength of about 97 per cent of alcohol. After separating by alcohol, and collecting the colloidal carbohydrate, its amount has been determined by conversion into glucose, by boiling with sulphuric acid, and estimating the glucose with the ammoniated cupric test. Observation testifies that the process yields extremely delicate and accurate results.

In the case of the dextrins, maltose, and sugars, the differentiation is effected by dividing the product into two equal parts, and taking the cupric oxide reducing power with the ammoniated cupric test of one part in its unaltered state, and of the other part after treatment with sulphuric acid, and to convert into glucose. From the information supplied regarding the condition of the two parts, the nature of the particular carbohydrate present is shown.

When such a plan of procedure is not adopted, and the cupric oxide reducing power is simply taken, no correct information can be obtained as to the nature and quantity of the body present. For instance, the portal blood may contain a low cupric oxide reducing dextrin, and if the cupric oxide reducing power, as it at first exists, were taken as expressive of glucose, which is what in reality has hitherto been done, the amount of carbohydrate actually present would be very much under-stated. At the same time, no information is supplied that the body consists of glucose. It is only by looking at the cupric oxide reducing power before and after treatment with sulphuric acid that a correct knowledge can be acquired, concerning not only the nature but likewise the amount of the principle which is present.

For conversion into glucose, sulphuric acid, to an extent to give a 2 per cent strength in the liquid operated upon, is added. A point to keep in view is to prevent the development of colour, as this interferes with the delicate determination of the result in the subsequent process of titration with the ammoniated cupric test. Hence, as it has been found by experience, it is necessary to use the pure acid.

The condition of the product must be kept in view to secure that the sulphuric acid added is not appropriated by displacing a weaker acid from any saline combination present. The product, if alkaline, must be brought to the neutral state before the sulphuric acid is added, or more sulphuric acid added in order to ensure the 2 per cent strength.

The process of boiling is carried on for different lengths of time according to the nature of the product dealt with. Information about this will be given when the products are being spoken of. When, as with cane sugar, and derivatives of cane sugar, boiling for a few minutes only is required, this can be done in an open flask, but when boiling for a long time, as for one hour or an hour and a quarter is required, it is necessary to use an inverted condenser to prevent loss by evaporation, which entails the risk of the higher degree of acid strength attained occasioning a destruction of carbohydrate. Observation has taught me the necessity of giving attention to this precaution.

What, of course, is wanted is a complete conversion into glucose by the acid treatment. If such is not obtained a vitiated result is given. With some products, as will be seen further on, on account of the resistance offered to conversion, it is advisable to employ a high pressure boiler and raise the temperature to 300° F. (140° C.).

After the conversion has been effected the liquid must be brought to the neutral state before titrating with the ammoniated cupric test. This requires to be done cautiously. A strong solution of potash is used for the purpose, and care must be taken to have the liquid cold before adding the potash, and to see that the temperature does not rise to any material extent during the process, in order to avoid leading to a destruction of glucose. Potash at a high temperature very readily destroys glucose, and by not giving attention to the point referred to error may occur.

With these preliminary remarks I will now proceed to deal with matter in detail.

Grape Sugar.

Grape sugar is characterised by producing the same cupric oxide reducing effect before and after treatment with sulphuric acid.

If by contact with an agent a product is presented which does not possess the same cupric oxide reducing power before and after treatment with sulphuric acid, it must be inferred that the grape sugar has been transformed into another body. Hitherto the carbohydrates have been known to be transformable by increased hydration attended with the acquirement of increased cupric oxide reducing power into grape sugar or glucose, which appears to occupy the position of a final product in the carbohydrate group.

The results to be detailed will show that within the animal system, contrary to existing notions, transformation in the opposite direction occurs, and glucose can be made to move into a product of less cupric oxide reducing power. By boiling with sulphuric acid this product is carried back again into glucose.

A ferment exists in the stomach and intestine of the rabbit which has the property of moving glucose into a body of less cupric oxide reducing power. This statement is substantiated by the following experiments:—

Grape Sugar placed in Contact with Strips of Stomach and Intestine.

Experiment.—The stomach of a recently killed rabbit (at a period of digestion) was removed, emptied of its contents, washed, and divided into two portions along the curvatures. One half was then cut into small strips and placed into a beaker with about 50 cub. centims. of water, and 20 cub. centims. of a solution of grape sugar containing 0·138 grm. of glucose, and exposed for one and a half hours to a temperature of 120° F. (48·8 C.). The contents of the beaker were now boiled with some crystals of sulphate of soda to precipitate the albuminous matters and prepare for testing, filtered (through glass-wool), washed, and the filtrate made up to 100 cub. centims., and divided into two equal parts. One part was titrated at once with ammoniated cupric test, whilst the other was subjected to boiling for one hour and a quarter with 1 cub. centim. o

sulphuric acid (giving a 2 per cent solution) in a flask affixed to a tube connected with an inverted condenser to prevent concentration through loss during boiling. When cold the contents of the flask were neutralised with potash, and brought to a known volume, and this liquid then titrated.

The two titrations showed a cupric oxide reduction reckoned for the whole product equivalent to that producible by the presence of the subjoined amount of glucose:—

Before sulphuric acid	0·080 grm.
After ,, ,, ...	0·134 ,,

Thus 0·138 grm. of glucose were taken, and by contact with the strips of stomach were converted into a body possessing a cupric oxide reducing capacity equivalent only to 0·80 grm. of glucose. By boiling with sulphuric acid this body was carried back into glucose, and it will be observed that the amount of glucose discovered after conversion and re-conversion was 0·134 grm. against 0·138 grm. started with.

The cupric oxide reducing power of the body produced was not far removed from that of maltose, the figures presented 0·080 and 0·134, standing in the relation of 58 to 100 instead of 61 to 100, the figures for maltose.

As a check the other half of the stomach was also cut into strips. These, however, instead of being used at once were first boiled with the 50 cub. centims. of water, and then the 20 cub. centims. of the solution of grape sugar containing 0·138 grm. of glucose were added. The beaker was exposed alongside the other for one and a half hours to 120° F. (48·8° C.). The same subsequent process of precedure as that which has been described was carried out, and the results yielded stood as follows:—

Before sulphuric acid	0·130 grm.
After ,, ,, ...	0·134 ,,

The figures here show that glucose existed. Hence with exposure of the strips to the temperature of boiling water previous to being placed in contact with the glucose no effect was exerted.

The small intestine of the animal was also used in identically the same manner. All the products, indeed, belonging to the experiments were placed side by side and treated alike; as there was enough intestine for the purpose, a duplicate observation was made in that part of the experiment where no preliminary boiling was resorted to. The same solution of grape sugar was used, and the same quantity, viz., 20 cub centims., containing 0·138 grm. glucose. The results of titration yielded the following figures as representing the cupric oxide reducing power of the product before and after subjection to the converting action of sulphuric acid expressed in glucose.

Intestine not subjected to Boiling before Employment.

I. Before sulphuric acid	0·086 grm.
After ,, ,, ...	0·138 ,,
II. Before ,, ,, ...	0·086 ,,
After ,, ,, ...	0·134 ,,

Intestine subjected to Boiling before Employment.

Before sulphuric acid	0·130 grm.
After ,, ,, ...	0·124 ,,

With the intestine, therefore, as with the stomach, no change was induced in the glucose where the strips were previously subjected to the influence of a boiling temperature. On the other hand, where the strips were employed before their activity was destroyed, the glucose was moved so as to make the product possess a reducing power (expressed in percentage relation) of 62 instead of 100 in the one case, and 64 instead of 100 in the other.

Experiment.—A similar experiment was performed with the employment of a larger quantity of glucose, 20 cub. centims. of a sulution of grape sugar, containing 0·400 grm. of glucose, were used, and the time of exposure to 120° (48·8 C.) was two hours.

Duplicate observations were made in the case of the stomach and intestine taken previously to being boiled. The results obtained stood as follows:—

0·400 *grm. of Glucose in Contact with Boiled Strips of Stomach* (*Rabbit*).

Before sulphuric acid	0·384 grm.
After ,, ,, ...	0·370 ,,

0·400 *grm. of Glucose in Contact with the Fresh Strips of Stomach.*

I. Before sulphuric acid	0·232 grm.
After ,, ,, ...	0·384 ,,
Relation 60 to 100.	
II. Before sulphuric acid	0·216 grm.
After ,, ,, ...	0·384 ,,
Relation 56 to 100.	

0·400 *grm. of Glucose in Contact with the Boiled Strips of Intestine.*

Before sulphuric acid	0·422 grm.
After ,, ,, ...	0·370 ,,

0·400 *grm. of Glucose in Contact with the Fresh Strips of Intestine.*

I. Before sulphuric acid	0·222 grm.
After ,, ,, ...	0·370 ,,
Relation 60 to 100.	
II. Before sulphuric acid	0·200 grm.
After ,, ,, ...	0·384 ,,
Relation 52 to 100.	

A marked consistency runs through all these results, except to a certain extent in the figures given by the titration of the product from the boiled strips of the intestine before treatment with sulphuric acid. Here the result comes out rather too high, but absolute accuracy can scarcely be expected to be obtained in every instance. The little loss otherwise noted throughout from the 0·400 grm. of glucose used may not unnaturally be looked for.

No further comment with regard to these experiments is needed. Looked at as a whole they speak in unmistakable terms and furnish a check within themselves.

Grape Sugar inclosed in Stomach and Intestine and exposed to Warmth.

Experiment.—50 cub. centims. of a solution of grape sugar were inclosed in the emptied and cleansed stomach of a freshly killed rabbit. The stomach was laid in a beaker, and exposed for 30 minutes to a temperature of 120° F. (48·8° C.). At the end of this time the contents were collected and submitted to analysis. The cupric oxide reducing power expressed as glucose stood as follows:—

Before sulphuric acid	1·738 grms.
After ,, ,, ...	2·352 ,,

Brought to a percentage relation, the reducing power before and after boiling with sulphuric acid here stands at 73 to 100.

25 cub. centims. of the same solution of grape sugar were also inclosed in a coil of the intestine, and a similar treatment carried out. The results yielded were:—

Before sulphuric acid	0·570 grm.
After ,, ,, ...	1·140 grms.

Here the cupric oxide reducing power of the product before re-conversion into glucose stood in the relation of 50 to 100 after re-conversion.

Experiment.—20 cub. centims. of a solution of grape sugar containing 0·185 grm. of glucose were inclosed in a thoroughly cleansed rabbit's stomach and exposed for two hours to 120° F. (48·8° C.). The analysis then yielded a cupric oxide reducing power expressed as glucose equivalent to:—

Before sulphuric acid	0·102 grm.
After ,, ,, ...	0·184 ,,

These figures stand in the relation of 55 to 100.

The same quantity of the grape sugar solution was introduced into a coil of intestine and similarly dealt with. A duplicate observation was here made. The results yielded were as follows:—

I. Before sulphuric acid	.. .. ..	0·108 grm.
After " "	.. .. ..	0·184 "
Relation 58 to 100.		
II. Before sulphuric acid	.. .. ..	0·106 grm.
After " "	.. .. ..	0·180 "
Relation 58 to 100.		

Looking at these results we see that the 0·185 grm. of glucose started with was transformed into products possessing a cupric oxide reducing power equivalent to 0·102, 0·108, and 0·106 grm. of glucose, and that after subjection to the re-converting influence of boiling with sulphuric acid, the amount of glucose found very closely corresponded with that actually employed.

Experiment.—20 cub. centims. of a solution of grape sugar containing 0·192 grm. of glucose were inclosed in a cleansed rabbit's stomach and exposed for one hour to a temperature of 120° F. (48·8° C.). An analysis of the contents at the end of this time gave the following results:—

Before sulphuric acid	.. .. ..	0·124 grm.
After " "	.. .. ..	0·184 "
Relation 67 to 100.		

The same proceeding was carried out with another stomach, with the difference that the exposure to 120° F. was for two hours instead of one.

Before sulphuric acid	.. .. ..	0·112 grm.
After " "	.. .. ..	0·206 "
Relation 54 to 100.		

A similar observation was conducted upon the intestine with the employment of the same quantity of the grape sugar solution; a duplicate was made in the case of the exposure for one hour to the temperature of 120° F.

Subjoined are the results obtained:—

Exposure for one hour to a Temperature of 120° *F.*

I. Before sulphuric acid	.. .. ..	0·106 grm.
After " "	.. .. ..	0·184 "
Relation 57 to 100.		
II. Before sulphuric acid	.. .. ..	0·108 grm.
After " "	.. .. ..	0·192 "
Relation 56 to 100.		

Exposure for two hours to a Temperature of 120° *F.*

Before sulphuric acid	.. .. ..	0·110 grm.
After " "	.. .. ..	0·184 "
Relation 59 to 100.		

(To be continued.)

CANTOR LECTURES OF THE SOCIETY OF ARTS.

The first of a short course of lectures "On the Alloys Used for Coinage" was delivered on Monday evening by Prof. W. Chandler Roberts, F.R.S., of the Royal Mint, the Hon. C. W. Fremantle, C.B., Deputy-Master of the Mint, in the chair.

The Lecturer pointed out that, although the gold coinage of this country is estimated to consist of no less than 700 tons of an alloy of gold and copper, information as to the nature and composition of the alloys used for coinage is far from being widely diffused. The views of many people on this important subject may still be expressed by the words of William Stafford, one of the earliest of English political economists, who, writing in 1581, makes a Knight "confesse that he could not perceave what hinderance it should be to the realme to have this metal more than that for our coyne," provided it "be stricken with the Prince's seale." The operations conducted in a modern Mint are chiefly remarkable for the extreme care and accuracy with which they are conducted. This being the case it was considered advisable to devote the present lecture to tracing the steps by which the machinery and appliances now in use have been arrived at; but it is very difficult to describe the history of the mechanical side of coining chronologically, because progress has been by no means continuous, as certain types of machines have survived persistently in some countries and have been abandoned in others, often to be again introduced with or without modification. Illustrations of this fact were then given. It is safe, however, to conclude that, while in civilised countries, at least since the 13th century, the designs of coins have always fairly represented the artistic culture of the periods at which they were struck, the appliances used in their manufacture have at times been distinctly behind the mechanical science of their days, as indicated in other technical arts. For the last fifty years, until the early part of 1882, the Mint in this country presented a striking example of this fact, as its machinery was admitted to be antiquated, while the general progress of mechanical science during the same period was probably greater than at any other time. It was further pointed out that, viewed from a modern stand-point, there have been periods during which the work of the metallurgist in the purification of the precious metals, and in verifying their standards of fineness, has been greatly in advance of that of the artist who engraved the dies or the mechanician who struck the coins.

The methods adopted by the Greeks in striking coins were indicated, and Prof. Roberts stated that, excepting some uncertainty as to the nature of the metal or alloy used for the manufacture of the Greek dies for coining, we know, thanks to the labours of M. Mongez, nearly as much of the methods adopted as if we had actually seen the ancient coiners at work.

The casting of coins, as conducted in late Roman times, was then described, and, as instances of curious survivals of casting operations, details were given of the production of bars of metal by casting in moulds of wet canvas, as seen by Jars in the Mint at Zellerfeld in the middle of the last century, and of the actual casting of coins of bell-metal in Paris in 1792.

Recent methods of coining were illustrated by cutting discs of metal by means of an appliance formerly used in the Mint in the Tower of London, and by striking them by a press devised in the Paris Mint early in the present century. Prof. Roberts said it had been contended that art had suffered serious loss by the replacement of the old hand-struck money by coins struck by machinery. It was, therefore, not a little remarkable that the artists who were connected with Mints appear to have been the very people to insist on the introduction of mechanical improvements. For instance, to take only the comparatively well-known names from those that were mentioned, Benvenuto Cellini described in 1568 the screw press, which, in a form modified by the genius of Boulton in 1790 so as to enable it to be worked by steam power, has only just been abandoned in the Mint of this country. Leonardo da Vinci, as Dr. Richter has recently shown, devised in 1515, for use in the Roman Mint, a method of "cutting out" discs of metal for conversion into coin, which was a great advance on the crude methods employed in the 16th century. Briot, Engraver-General of the Paris Mint, invented a machine in the reign of King Charles I., which depends upon a principle definitely adopted in the new lever coining-presses of the English Mint; and his pupil Simon, the greatest engraver England has ever had, employed an elaborate mechanical device which enabled him to produce one of the most beautiful coins known. In order to meet the objection that the artistic side of minting was hardly within the province of the chemist, Prof. Roberts quoted Biringuccio, one of the greatest of the early metallurgists, whose advice to a Mint Master, written in 1540, might be briefly stated as follows:—"If the coins are very accurate as regards standards of fineness but small profits can be made, while if too much base metal is introduced the

execrations of the people will follow; but special care should be devoted to the preparation of dies for striking artistic coins, with a view to give the people pleasure in things they are obliged to use."

The next lecture, on Monday the 24th, will be devoted to the consideration of the composition and "standard fineness" of the alloys used in ancient and modern times.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ALUMINUM.

The atomic weight of aluminum has been determined by Berzelius, Mather, Tissier, Dumas, Isnard, Terreil, and Mallet. The early calculations of Davy and of Thomson we may properly disregard.

Berzelius's† determination rests upon a single experiment. He ignited 10 grms. of dry aluminum sulphate, $Al_2(SO_4)_3$, and obtained 2·9934 grms. of Al_2O_3 as residue. Hence, if S=31·987 and O=15·9633, Al=27·243.

In 1835‡ Mather published a single analysis of aluminum chloride, from which he sought to fix the atomic weight of the metal. 0·646 grm. of Al_2Cl_6 gave him 2·056 of AgCl and 0·2975 of Al_2O_3. These figures give worthless values for Al, and are included here only for the sake of completeness. From the ratio between AgCl and Al_2Cl_6, Al=28·925.

Tissier's|| determination, also resting on a single experiment, appeared in 1858. Metallic aluminum, containing 0·135 per cent of sodium, was dissolved in hydrochloric acid. The solution was evaporated with nitric acid to expel all chlorine, and the residue was strongly ignited until only alumina remained. 1·935 grm. of Al gave 3·645 grm. of Al_2O_3. If we correct for the trace of sodium in the aluminum, we have Al=27·073.

Essentially the same method of determination was adopted by Isnard,§ who, although not next in chronological order, may fittingly be mentioned here. He found that 9 grms. of aluminum gave 27 grms. of Al_2O_3. Hence Al=26·938.

In 1858 Dumas,¶ in connection with his celebrated revision of the atomic weights, made seven experiments with aluminum chloride. The material was prepared in quantity, sublimed over iron filings, and finally re-sublimed from metallic aluminum. Each sample used was collected in a small glass tube, after sublimation from aluminum in a stream of dry hydrogen, and hermetically enclosed. Having been weighed in the tube, it was dissolved in water, and the quantity of silver necessary for precipitating the chlorine was determined. Reducing to a common standard, his weighings give the quantities of Al_2Cl_6 stated in the third column, as proportional to 100 parts of silver:—

1·8786 grms. Al_2Cl_6	=	4·543 grms. Ag.		41·352	
3·021	,,	7·292	,,	41·459	—Bad.
2·399	,,	5·802	,,	41·348	
1·922	,,	4·6525	,,	41·311	
1·697	,,	4·1015	,,	41·375	
4·3165	,,	10·448	,,	41·314	
6·728	,,	16·265	,,	41·365	

In the second experiment the Al_2Cl_6 contained traces of iron. Rejecting this experiment the remaining six give a mean of 41·344 ± 0·007. Hence Al=27·441 ± 0·082.

In consequence of these figures of Dumas, the atomic weight of aluminum has generally, of late years, been put at 27·5, and the lower results deduced from the work of other investigators have been disregarded.

In 1879 Terreil* published a new determination of the atomic weight under consideration, based upon a direct comparison of the metal with hydrogen. Metallic aluminum, contained in a tube of hard glass, was heated strongly in a current of dry hydrochloric acid. Hydrogen was set free, and was collected over a strong solution of caustic potash. 0·410 grm. of aluminum thus were found equivalent to 508·2 c.c., or 0·0455 grm. of hydrogen. Hence Al =27·033.

About a year after Terreil's determination appeared the lower value for aluminum was thoroughly confirmed by J. W. Mallet.† After giving a full resumé of the work done by others, exclusive of Isnard, the author describes his own experiments, which may be summarised as follows:—

Four methods of determination were employed, each one simple and direct, and at the same time independent of the others. First, pure ammonia alum was calcined, and the residue of aluminum oxide was estimated. Second, aluminum bromide was titrated with a standard solution of silver. Third, metallic aluminum was attacked by caustic soda, and the hydrogen evolved was measured. Fourth, hydrogen was set free by aluminum, and weighed as water. Every weight was carefully verified, the verification being based upon the direct comparison, by J. E. Hilgard, of a kilogramme weight with the standard kilogramme at Washington. The specific gravity of each piece was determined, and also of all materials and vessels used in weighings. During each weighing both barometer and thermometer were observed, so that every result represents a real weight *in vacuo*.

The ammonium alum used in the first series of experiments was specially prepared, and was absolutely free from ascertainable impurities. The salt was found, however, to lose traces of water at ordinary temperatures; a circumstance which tended towards a slight elevation of the apparent atomic weight of aluminum, as calculated from the weighings. Two sets of experiments were made with the alum; one upon a sample air-dried for two hours at 21°—25°, the other upon material dried for twenty-four hours at 19°—26°. These sets, marked A and B respectively, differ slightly; B being the less trustworthy of the two, judged from a chemical standpoint. Mathematically it is the better of the two. Calcination was effected with a great variety of precautions, concerning which the original memoir must be consulted. To Mallet's weighings I append the percentages of Al_2O_3 deduced from them:—

Series A.

Grms.		Grms.			
8·2144	of the alum gave	0·9258	Al_2O_3.	11·270	per cent.
14·0378	,,	1·5825	,,	11·273	,,
5·6201	,,	0·6337	,,	11·275	,,
11·2227	,,	1·2657	,,	11·278	,,
10·8435	,,	1·2216	,,	11·266	,,

Mean 11·2724 ± 0·0014

Series B.

Grms.		Grms.			
12·1023	of the alum gave	1·3660	Al_2O_3.	11·287	per cent.
10·4544	,,	1·1796	,,	11·283	,,
6·7962	,,	0·7670	,,	11·286	,,
8·5601	,,	0·9654	,,	11·278	,,
4·8992	,,	0·5528	,,	11·283	,,

Mean 11·2834 ± 0·0011

Combined, these series give a general mean of 11·2793 ± 0·0008. Hence Al=27·075 ± 0·011.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 177.
‡ *Silliman's Amer. Journ.*, 27, 241.
|| *Compt. Rend.*, 46, 1105.
§ *Ibid.*, 66, 508. 1868.
¶ *Ann. Chim. Phys.*, (3), 55, 151. *Ann. Chem. Pharm.*, 113, 26.

* *Bulletin de la Soc. Chimique*, 31, 153.
† *Phil. Trans.*, 1880, p. 1003.

The aluminum bromide used in the second series of experiments was prepared by the direct action of bromine upon the metal. The product was repeatedly distilled, the earlier portions of each distillate being rejected, until a constant boiling-point of 263·3° at 747 m.m. pressure was noted. The last distillation was effected in an atmosphere of pure nitrogen, in order to avoid the possible formation of oxide or oxy-bromide of aluminum; and the distillate was collected in three portions, which proved to be sensibly identical. The individual samples of bromide were collected in thin glass tubes, which were hermetically sealed after nearly filling. For the titration pure silver was prepared, and after fusion upon charcoal it was heated in a Sprengel vacuum in order to eliminate occluded gases. This silver was dissolved in specially purified nitric acid, the latter but very slightly in excess. The aluminum bromide, weighed in the sealed tube, was dissolved in water, precautions being taken to avoid any loss by splashing or fuming which might result from the violence of the action. To the solution thus obtained the silver solution was added, the silver being something less than a decigramme in deficiency. The remaining amount of silver needed to complete the precipitation of the bromine was added from a burette, in the form of a standard solution containing one milligramme of metal to each cubic centimetre. The final results were as follows, the figures in the third column representing the quantities of bromide proportional to 100 parts of silver. Series A is from the first portion of the last distillate of Al_2Br_6; series B from the second portion, and series C from the third portion:—

		Series A.			
6·0024 grms.	Al_2Br_6 =	7·2793 grms.	Ag.	82·458
8·6492	,,	10·4897	,,	82·454
3·1808	,,	3·8573	,,	82·462
		Series B.			
6·9617	,,	8·4429	,,	82·456
11·2041	,,	13·5897	,,	82·445
3·7621	,,	4·5624	,,	82·459
5·2842	,,	6·4085	,,	82·456
9·7338	,,	11·8047	,,	82·457
		Series C.			
9·3515	,,	11·3424	,,	82·447
4·4426	,,	5·3877	,,	82·458
5·2750	,,	6·3975	,,	82·454
				Mean 82·455 ± 0·001

Hence Al = 27·046 ± 0·061.

The high probable error of this result is due to the high probable error of the atomic weight of bromine.

The experiments to determine the amount of hydrogen evolved by the action of caustic soda upon metallic aluminum were conducted with pure metal, specially prepared, and with caustic soda made from sodium. The soda solution was so strong as to scarcely lose a perceptible amount of water by the passage through it of a dry gas at ordinary temperature. As the details of the experiments are somewhat complex, the original memoir must be consulted for them. The following results were obtained, the weight of the hydrogen being calculated from the volume by Regnault's data corrected for the latitude and elevation of the University of Virginia:—

Weight of Al.	Vol. of H.	Wt. of H.	At. Wt.
0·3697 grm.	458·8 c.c.	0·04106 grm.	27·012
0·3769 ,,	467·9 ,,	0·04187 ,,	27·005
0·3620 ,,	449·1 ,,	0·04019 ,,	27·002
0·7579 ,,	941·5 ,,	0·08425 ,,	26·998
0·7314 ,,	907·9 ,,	0·08125 ,,	27·006
0·7541 ,,	936·4 ,,	0·08380 ,,	26·996
			Mean 27·005 ± 0·0032

The closing series of experiments was made with larger quantities of aluminum than were used in the foregoing set. The hydrogen, evolved by the action of the caustic alkali, was dried by passing it through two drying tubes containing pumice stone and sulphuric acid, and two others containing asbestos and phosphorus pentoxide. Thence it passed through a combustion-tube containing copper oxide heated to redness. A stream of dry nitrogen was employed to sweep the last traces of hydrogen into the combustion-tube, and dry air was afterwards passed through the entire apparatus to reoxidise the surface of reduced copper, and to prevent the retention of occluded hydrogen. The water formed by the oxidation of the hydrogen was collected in three drying tubes. The results obtained were as follows. The third column gives the amount of water formed from 10 grms. of aluminium:—

2·1704 grms. Al	gave	2·1661 grms. H_2O.	9·9802
2·2355	,,	2·9292	,,	9·9785
5·2632	,,	5·2562	,,	9·9867
				Mean 9·9818 ± 0·0017

Hence Al = 26·998 ± 0·007.

In combining the various determinations of the atomic weight of aluminum into one general mean, we must arbitrarily assign weight to the single experiments of Berzelius, Isnard, Tissier, and Terreil. This may fairly be done by giving to each the probable error, and therefore the weight, of a single observation in Dumas's series. Mather's work may be ignored altogether:—

From Berzelius	Al =	27·243	± 0·201
,, Tissier	,,	27·096	0·201
,, Isnard	,,	26·938	0·201
,, Dumas	,,	27·441	0·082
,, Terreil	,,	27·033	0·201
,, Mallet's alum experiments	,,	27·075	0·011
,, ,, Al_2Br_6 ,,	,,	27·046	0·061
,, ,, H ,,	,,	27·005	0·003
,, ,, H_2O ,,	,,	26·998	0·007
General mean	,,	27·0092	0·0028

If O = 16, Al = 27·075. Taking Mallet's work alone, Al = 27·0089 ± 0·0028.

Evidently all the data except Mallet's might be rejected without affecting sensibly the final result. Dumas's work is clearly vitiated by constant errors, but the determinations by Isnard, Tissier, and Terreil may be regarded as having some confirmative value.

The following additional note has been communicated by the author:—

Since the chapter on aluminum was written, a new determination has been made by Baubigny.* Two calcinations of $Al_2(SO_4)_3$, left a mean percentage of Al_2O_3 of 29·832. Hence Al = 26·983; or, if SO_3 = 80, Al = 27·018.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, January 22nd, 1884.

H. E. ROSCOE, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

"*On a New Variety of Halloysite from Maidenpek, Servia,*" by H. E. ROSCOE, LL.D., F.R.S, President

This mineral, one of the few peculiar to Servia, was given to me by Mr. James Taylor, lately a resident at Maidenpek. It is a very soft (h. = 2·5), whitish green, non-crystalline mineral, having a conchoidal waxy fracture. It is translucent in thin films, but opaque in mass,

* *Comptes Rendus*, 97, 1369.

and adherent to the tongue. Its specific gravity is 2·07. On exposure to air it loses a portion of its combined water, and becomes of a dead-white colour and more opaque. The greenish tint is due to the presence of small quantities of copper oxide (1·11 per cent). The following analyses show that this is a more highly hydrated variety than most of the specimens of Halloysite hitherto examined, and that it corresponds to the formula $Al_2O_3 2SiO_2 + 5H_2O$.

Analysis of Halloysite from Maidenpek.

	I.	II.	Mean.
Al_2O_3	32·81	32·58	32·69
SiO_2	37·59	37·70	37·64
H_2O	28·59	28·27	28·43
CuO	1·11	—	1·11
	100·10	—	99·87

The calculated composition for the above formula is—

Al_2O_3	32·86
SiO_2	38·37
H_2O	28·77
	100·00

A specimen of a similar mineral from the same locality was found by Tietze to contain:—

$Al_2O_3(Fe_2O_3)$	25·20
SiO_2	44·96
H_2O	29·50
	99·66

Corresponding nearly with the formula $Al_2O_3 3SiO_2 + 6H_2O$, showing a distinct difference in the relation of alumina to silica from that existing in the specimen in question.

"*On a Method of Mounting Electrical Resistances*," by Arthur W. Waters, F.G.S., &c.

NOTICES OF BOOKS.

Annual Report of the Director of the Mint to the Secretary of the Treasury, for the Fiscal Year ending June 30th, 1883. Washington: Government Printing Office, 1883.

The interest that is attached to this report, chiefly statistical, is of a two-fold character, and such as will render its study by those who are at all interested in the highly complex question regarding the monetary state of the world one of considerable value. The first part of the report relates to the operations of the Mints and Assay Offices in the United States during the fiscal year ending June 30th, 1883, and the present state of the coinage and metallic circulation. In the second part are printed the reports received from foreign Mints regarding their monetary statistics in reply to the enquiries addressed to the different Governments by the United States Secretary of State in reference to the condition of their gold and silver coinage and currency. By the aid of the information that has been thus furnished a fair estimate is obtained of the world's coinage, the paper and specie circulation of the principal countries of the world and the production of gold and silver in the world. Besides the customary statistics relating to the coinage operations at the different Mints in the United States, tables are given showing the production of gold and silver and the consumption of these metals in the arts and manufactures and the total United States circulation and its disposition. A few legislative measures are recommended with a view to the discontinuance of the coinage of certain pieces which are considered unsuitable as media of exchange and also the repeal of the act authorising the coinage of the trade dollar.

A Digest of Patent Law and Cases, incorporating the Provisions of the Patents Act, 1883. By H. A. A. Gridley, M.A., Barrister-at-law. London: Marcus Ward and Co.

In the preface to this useful volume the compiler states that the object of the work is "to present as concisely as possible the Law of Patents, altered as it is by the Patents for Inventions Act, 1883." Considerable pains have evidently been taken in carrying out this object, and so rendering the book one that will be of service both to the numerous class of inventors who require to have some knowledge of the law relating to patents and to the legal profession. The full and clear manner in which the legal technicalities of each clause are expounded, and the large number of cases quoted bearing on the different points, and the decisions that have been arrived at, will render this treatise a useful one for reference.

In the introductory chapter a short historical sketch is given of the origin of monopolies in this country, followed by a *précis* of the procedure now necessary for obtaining a patent compared with the procedure that formerly existed under the repealed Patents Acts, showing in a concise manner the alterations that have been effected by the new Act. The first two chapters, in which are discussed "the true and first Inventor" and the Invention, will afford much information regarding these two knotty questions to those intending to seek legal protection for their inventions by showing how far the manner of a new manufacture or its novelty may legally claim to have a patent granted. These matters form a useful introductory to the main part of the volume, on the proceedings under the new Patents Act, which is divided into chapters in which the various sections of the Act are analysed and much matter illustrative of the legal points introduced, cases cited, decisions quoted, &c. In an appendix are given the rules made by the Board of Trade relating to applications for patents for inventions, registration of patents, list of fees, and rules for appeals to the law officers.

The British Journal Photographic Almanac and Photographer's Daily Companion for 1884. Edited by W. B. Bolton. London: Henry Greenwood.

Even if the usual item of Almanacs, eclipses of the sun, had been omitted, which phenomena, fortunately for photographers, are by the nature of things of very unfrequent occurrence and of short duration, this volume would still possess much matter useful for all classes of photographers and sufficient in variety and extent to fill up advantageously leisure moments for no inconsiderable time. In addition to a mass of contributions, "literary and scientific," many of them from the pens of men well known in photographic spheres, we have much information of a more solid character in the way of receipts for developers and such like which may perhaps be found more or less valuable by the photographer who has time or inclination for experimental work. The progress that has been made during the past year by the enthusiastic workers in this nineteenth century art, and the extent and rapidity with which this instructive form of amusement is spreading, as is shown by the number of new photographic societies that have sprung up, are duly recorded by the editor in his summarised notes. The most noteworthy achievements of photography for science during the period are undoubtedly Mr. Common's picture of the nebula in Orion, and the photographic work connected with the eclipse of last May.

Among many other notes that the amateur or professional photographer may find to be of considerable use to him, especially if his knowledge of chemistry is limited, that on atomic and equivalent weights will be of material assistance in working out the calculations connected with double decomposition. Here, in addition to the atomic weights of many compounds used by the photographer, which by the way ought rather to have been termed molecular weights, the "equivalent" weights are given referred

to one uniform scale, the salts of monad elements. This method of tabulating these numbers, although in certain cases advantageous, is open to some objections, liable to mislead those whose notions of chemical decompositions are at all hazy. For instance, in the case of crystallised salts, if weighed in such a form, their water of crystallisation, if they possess any, would require to be taken into account; but such weights could not certainly be called "equivalent" in the true chemical sense, and why should these molecules of water be considered as forming part of the "equivalent" weight in such a compound as citric acid and ignored in baric chloride or sodic carbonate?

Report of the Commissioner of the Imperial Mint for the year ending the 30th of the 6th month of the 16th year of Meiji (30th June, 1883). Hiogo: 1883.

THIS the 13th Report of the Imperial Mint of Japan for the financial year ending the 30th of June, 1883, gives the usual statistics respecting the imports of gold and silver bullion into the Mint, and the amounts of these metals that have passed through the coinage department during the last year. The total value of the coins, gold, silver, and copper, that have been struck at the Mint since its commencement has reached the sum of 108,966,830·75 yen.

Some new regulations have been introduced with regard to the acceptance of bullion for coinage purposes, and for refining. Formerly the smallest quantities of bullion received for coinage were 50 ozs. of gold and 500 ozs. of silver; these amounts have now been reduced to 30 ozs. and 300 ozs. respectively. The charges made for coining or refining these metals have likewise been changed.

The part of this report which most interests us is that relating to the chemical department of the Mint, which is under the supervision of Mr. W. Gowland, F.C.S. The Japanese, we notice, carry on their bullion refining as well as the manufacture of sulphuric acid, soda, and some other chemicals in conjunction with their coining processes. In refining their bullion the ordinary sulphuric acid method is employed; the mother-liquors from which the cupric sulphate has been separated by crystallisation are concentrated by evaporation, and the recovered acid again used in the process. The amounts of the pure metals obtained from the refinery for the past year were about 64,000 ozs. of gold and 806,000 ozs. of silver. The decrease that has taken place in the demand for cupric sulphate has caused the introduction of Gutzkow's process—precipitation of the silver by ferrous sulphate—as mentioned in the last report; data, however, are not given to show how far this method, exceedingly good on a small scale, can be carried on economically when dealing with large quantities of the metals. Besides the manufacture of nitric, hydrochloric, and sulphuric acids, as well as of soda, a building has been erected for the making of bleaching-powder. The trials that have been made, however, of this last addition to the establishment have not been quite satisfactory, owing to the defective character of the chlorine generator and the heat of the weather.

An interesting analysis is given of an ingot of silver which was of such brittleness that on attempting to cut out an assay piece from it it broke into halves. The analysis showed no zinc, arsenic, or antimony, but 0·756 per cent of bismuth and 0·857 per cent of lead, with traces of gold, copper, and iron. When purifying such silver by cupellation it is found that the lead appears to be more easily oxidised than the bismuth, the latter metal being obstinately retained by the silver. The preliminary results obtained from an investigation of silver bismuth alloys demonstrate that (1) brittleness of silver is frequently due to the presence of bismuth; (2) if bismuth is present in certain proportions in an ingot of silver, the ingot will not be uniform in composition; (3) when bismuth and lead have to be removed from silver by oxidation the former metal is only removed after most of the latter has been oxidised.

An unusually large quantity of gold has been found in the crude copper from certain of the Government mines; in one case as much as 26 ozs. of the precious metal have been found per ton of the copper.

The Mechanical Department of the Japanese Mint, under the able superintendence of Mr. MacLagan, has now taken the form of a complete engineering works capable of constructing all the necessary machines as well as effecting repairs, thus rendering the establishment greatly independent of external aid.

CORRESPONDENCE.

WARNING.

To the Editor of the Chemical News.

SIR,—I wish to call the attention of Managers of Chemical Works and Analytical Chemists to the following letter which appeared in the *Western Morning News* of March 17:—

"Sir,—The public are warned against a young German-Swiss, who is going about the South of England pretending to seek employment, and stating falsely that he was assistant to Stevenson Macadam, professor of chemistry, of Edinburgh. He was at Falmouth on the 11th inst., and gave the name of Weiss, saying that he was from Zurich. The police doubtless will be glad to hear of his whereabouts.—Yours truly, A. LLOYD FOX, Penmere, Falmouth, March 15th, 1884."

I have no doubt this is the same person who favoured most of the Chemical Works in this neighbourhood with a visit about a month since, and succeeded in several instances in obtaining pecuniary assistance.

Introducing himself as Dr. Weisse, he represented himself to be an Analytical Chemist, Ph.D. (Heidelberg), and F.C.S., stating that he had been employed at the St. Rollox Works, and giving Professor Ramsay, of Bristol, as a reference, &c.

Prof. Ramsay said that he does not know such a person, neither can I find that name in the list of Fellows of the Chemical Society for 1883.—I am, &c.,

HENRY S. BILLING.

The Plymouth Chemical Works, Plymouth.
March 18th, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 3, January 21, 1884.

Dust accompanying Snow.—M. Nordenskiöld.—Snow which fell near Stockholm about the end of December was contaminated with small quantities of a black dust. A little of this matter which had been collected was found to contain much carbonaceous matter. On ignition it left a red residue of ferric oxide, silica, phosphorus, cobalt, and nickel, the two latter in relatively large proportions.

Conductivity of very Dilute Saline Solutions.—E. Bouty.—The author has experimented upon solutions so dilute that their density and viscosity differed little from those of pure water. Their electric conductivity was still enormous in comparison with that of pure water, and was closely connected with their chemical composition. Let

p be the weight of salt contained in the unit of weight of the solution, e its chemical equivalent, c the conductivity of a liquid cylinder of a length and section taken as unity. There is for each salt a value p, below which the conductivity varies proportionally to the weight of the dissolved salt: if we compare the conductivities of the various salts we find that they are inversely as the equivalents, and we may write $c=k\frac{p}{e}$. The coefficient k is the same for all the neutral salts which the author has studied. If we put $p=e$, *i.e.*, if we consider solutions which contain in like volume the same number of mols. of the different salts, the conductivity c is the same for all. The molecular conductivity of all neutral salts is the same.

Repulsion of Two Consecutive Portions of the same Current.—M. Izarn. The author remarks that in Ampère's experiment for demonstrating this repulsion no one has yet noticed that if we turn the apparatus so that the current traversing the mercury is obliged to return in order to pass through its horizontal portions, these latter must be attracted, whilst the effects upon the other portions remain as in the first case.

Formation of Nacreous Crystals of Sulphur.—D. Gernez.—If we take a U-tube, the diameter of which does not exceed 0·002 metre, introduce sulphur into it, and heat to 160°, and then plunge it into boiling water, the liquid produces the desired variety of crystalline sulphur.

Determination of the Equivalent of Chromium by means of its Sesqui-sulphate.—H. Baubigny.—The author's mean result is Cr=26·016 if S=16, or Cr=26·050 if S=16·037. In a later experiment he finds Cr=26·081 or 26·116, according as S=16, or =16·037. The determinations of Kessler gave Cr=26·15, and those of Siewert Cr=26·047.

The Liquefaction of Hydrogen.—M. Wroblewski.—Condensed hydrogen refrigerated by means of boiling oxygen becomes liquefied when released from pressure.

Products of the Reduction of Erythrite by Formic Acid.—A. Henninger.—Formic acid causes the polyvalent alcohols to descend successively in their valence. If erythrite is boiled with 2½ parts of formic acid for six hours, and the excess of acid is subsequently distilled off, raising the temperature at the end towards 190° to 200°, the residue congeals into a radiating mass containing tetraformine, and yielding on destructive distillation crotonylene-glycol, crotonic-aldehyd, dihydro-furfurane, and erythrane.

An Aromatic Diacetone.—C. Louise.—The author has obtained dibenzoyl-mesitylene by causing benzoyl-chloride to react upon benzoyl-mesitylene.

Determination of Moisture in Amylaceous Matters.—L. Bondonneau.—Moist starch, if suddenly heated to temperatures above 60°, produces a paste which forms an impenetrable stratum in which the moisture of the interior is imprisoned. The author proposes the following process:—If the sample is free from acidity, 5 to 10 grms. are weighed out, and spread in a thin stratum in a rectangular capsule of glass, porcelain, or platinum, which is then introduced into a cold Courlier stove. The temperature is then raised slowly and gradually (in about three hours) to 60°; then it is raised to 100° in one hour, and this heat is maintained until the weight is constant. If the sample is acid it must be cautiously neutralised with ammonia, and is then kept until nearly dry at a heat not above 40°, when it is raised to 100° as before.

Moniteur Scientifique, Quesneville.
February, 1884.

Preparation of the Pentathionates and on Pentathionic Acid.—S. Shaw and Watson Smith.—From the *Journal of the Chemical Society.*

Magnesium Bromide and Iodide.—Otto Lerch.

Oxides of Manganese.—O. T. Christenson.—These two papers are from the *Journal fur Praktische Chemie*, and have been noticed under that head.

Certain Bromo-derivatives obtained in the Manufacture of Bromine.—S. Dyson.—From the *Journal of the Chemical Society.*

Oxidation of the Sulphur Compounds in Caustic Soda-lye.—Dr. G. Lunge.—In presence of an excess of soda, sodium sulphite is transformed during concentration into hyposulphite, by the action of the atmospheric oxygen alone. If the lye at the moment of caustification is agitated by means of a current of air, the sulphide disappears entirely. But, subsequently, when the concentration has raised the boiling-point to about 140°, the hyposulphite splits up into sodium sulphide and sulphite. The former may be again oxidised by the same process, and the cycle of reactions being repeated all the sulphide may be converted into sulphite; but this change, at temperatures below 360°, requires a very long time. Sodium sulphite is oxidised by the air to sulphate, the more rapidly the higher the temperature; at a red heat the introduction of a current of air converts all the sulphide into sulphate. Sodium sulphide may also be oxidised by means of nitre. The reaction begins below 140°, and if the oxidising agent is not in excess, which is always the case in practice, it is entirely changed into nitrite. This body subsequently reacts upon the sulphide, not yet attacked, and converts it into sulphite. There the reciprocal action ends, the sulphite and nitrite remaining in presence of each other up to nearly 360°. At this temperature sulphate is formed with liberation of nitrogen. The action of nitrate never produces hyposulphite. That which is formed in the crude caustic lyes is produced at the expense of atmospheric oxygen. The hyposulphite is relatively very stable. The nitre passes at first into the state of nitrate, which, in presence of oxidisable sulphur, is totally reduced with liberation of ammonia. This reaction begins at about 140° in iron vessels. Along with the production of ammonia, which reaches its maximum at 180°, and still continues above 300°, the formation of free nitrogen is observed. The maximum useful effect with nitre is obtained by causing it to react at a low temperature. We are thus led to the following rational procedure:—The sulphide is first oxidised to hyposulphite by means of atmospheric oxygen. As the hyposulphite is only oxidised slowly by the air when the temperature has reached 140° there is no splitting up into sulphide and sulphite. It is well not to add the nitre until the temperature has risen to the decomposition point into sulphide and sulphite, and to introduce it then by small quantities. In practice the first dose of nitre is added as soon as the presence of sodium sulphite is detected in the liquid, and the last portions about 300° to 360°.

Solid and Liquid Illuminating Agents.—L. Field.—Lectures delivered before the Society of Arts.

Antiseptics and Bacteria.—P. Miquel.—The author has drawn up a table of the minimal proportions capable of preventing the putrefaction of 1 litre of beef broth neutralised. The most powerful agent is mercury biniodide, which is ten times as active as chlorine. Salicylic and benzoic acids, phenol and arsenious acid, occupy relatively very low ranks. The smallest quantities required are mercury biniodide, 0·025 grm.; chlorine, 0·25; salicylic acid, 1·00; phenol, 3·00; arsenious acid, 6·00; naphthaline has no antiseptic action.

German Patents for Improvements in Colouring Matters.—A list of abridgments of specifications.

Determination of Free Fatty Acids in Oils.—Ch. E. Schmitt.

Adulterations of Industrial Chemical Products carried on abroad.—A further reference to the tartar-emetic question.

Journal de Pharmacie et de Chemie.
Tome ix., February, 1884.

Emetics of Mucic and Saccharic Acids.—D. Klein.—From the *Comptes Rendus.*

Naphthol.—An account of the medicinal uses of this compound, which appears to be not unattended with danger.

Citric and Tartaric Acids.—B. J. Grosjean.—From the Chemical News.

The Absorption-spectrum of Blood in the Violet and Ultra-violet Region.—J. L. Soret.—From the *Comptes Rendus.*

The Existence and Distribution of Eleidine in the Bucco-œsophagian Mucous Membrane of Mammals.—L. Ranvier.—From the *Comptes Rendus.*

Cosmos les Mondes,
No. 2, January 12, 1884.

Siliceous Bronze.—H. Vivarez proposes a siliceous bronze as the best material for telegraph and telephone wires. Its conductive power is comparable to that of copper, and its mechanical resistance is superior to that of iron. For wires of galvanised iron weighing 155 kilos. per kilometre may be substituted wires of this bronze weighing only 28 kilos. Siliceous bronze does not rust like iron, but becomes covered with a film of oxide, which is a good insulator.

No. 3, January 19, 1884.

Utilisation of Woollen and Cotton Rags.—M. Heddebault has invented a method for extracting wool in the state of a solution from tissues in which cotton and wool are mixed. On submitting the rags to a current of superheated steam at the pressure of 5 atmospheres, the wool melts, and falls to the bottom of the vessel, while the cotton or other vegetable matter remains in a state fit for use in paper-making. The dissolved wool may be evaporated to dryness, but remains soluble in water, and is used by manure-makers as a source of nitrogen under the name of azotine. [This process was in use at Wakefield more than a quarter of a century ago!—*Ed.* C.N.]

No. 4, January 26, 1884.

This issue does not contain any chemical papers.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., November, 1883.

Action of Light upon Colours.—M. Decaux.—Already noticed.

Revue Universelle des Mines, de la Metallurgie, &c., Nos. 2 (Sept. and Oct.) and 3 (Nov. and Dec.), 1883.

These numbers contain no chemical matter.

MISCELLANEOUS.

The Parkes Museum.—Sir Joseph Lister, Bart, will take the Chair at the Parkes Museum on Thursday, March 27, at 8 p.m., when Mr. Watson Cheyne will give a demonstration of all the principal types of Micro-organisms. Tickets for admission can be obtained through Members of the Museum.

Skrivanow Battery.—D. Monnier.—The element is formed of a sheet of zinc and of silver chloride wrapped in parchment paper, immersed in an alkaline liquid of 75 parts of potassa in 100 of water. The case is a small trough of gutta-percha, capable of being hermetically closed. The conductors and outer contacts are of silver. The entire element weighs 100 grms. The electromotive force of this element is 1·45 to 1·50 volts, and it can give a current of 1 ampère for about an hour.—*Comptes Rendus.*

MEETINGS FOR THE WEEK

Monday, Mar. 24th.—Medical, 8.30.
— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S.
Tuesday, 25th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.
— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
Wednesday, 26th.—Society of Arts, 8. "Vital Steps in Sanitary Progress," by B. W. Richardson, M.D.
Thursday, 27th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
Friday, 28th.—Royal Institution, 8. "The Two Manners of Motion of Water," by Prof. Osborne Reynolds, at 9.
— Society of Arts, 8. "Trade Routes in Afghanistan," by Griffin W. Vyse.
— Quekett Microscopical Club, 8.
Saturday, 29th.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

THE CHEMICAL NEWS.

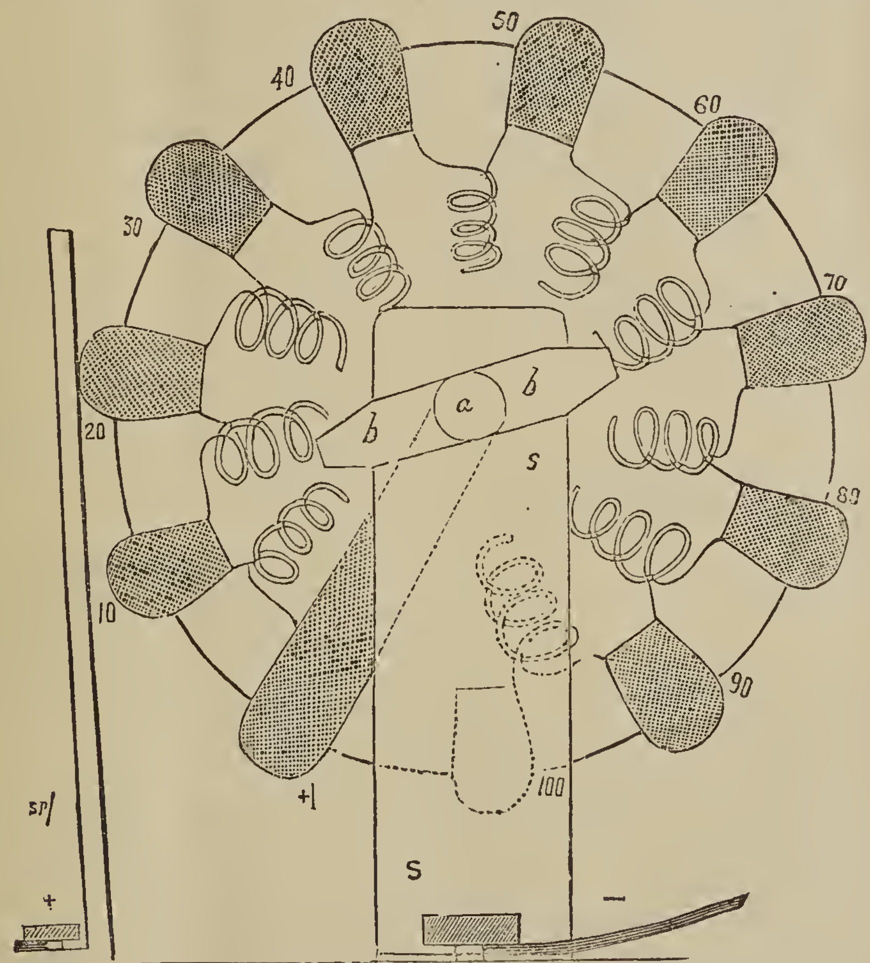
VOL. XLIX. No. 1270.

ON A METHOD OF MOUNTING ELECTRICAL RESISTANCES.*

By ARTHUR W. WATERS, F.G.S., &c.

A SHORT time ago I came to the conclusion that there was a strong probability of the variations in the electrical resistances of the human body giving some indication as to how various climatic changes affected different constitutions. This idea forced itself on me in consequence of an investigation concerning the changes of the body temperature, as affected by meteorological conditions, having brought out the interesting fact, that the average changes in the 5 to 6 p.m. clinical temperature of a sufficient number of invalids† follows the curve of the absolute moisture or of the temperature, both of which are very similar and the current is thus led away from the axis. Round the border of this disk German silver flanges* or bosses are attached, and one of these (x) is connected by a stout strip of copper to the axle. Between this and the next boss a resistance coil of fine German silver wire wound double on a small reel is attached, and between each of the other bosses a similar coil is placed and the two ends severally soldered to the adjoining German silver projection. The disk is revolved by means of a bone or ebonite handle, b, and these bosses are thus brought against a strong spring (sp), up which the current is led. If the flange connected with the axle is brought against this spring, then there is practically no resistance; but if any other flange is against the spring, then the current must pass through one or more reels of resistance. As figured it would go through two reels of 10 ohms each, and if it went through all the reels we get a total of 100 ohms. As arranged, one boss does not leave the spring until the next is in contact.

The complete instrument consists of four such disks similarly mounted and put into connexion, and on the first disk the reels are 1 ohm, on the second 10, and on the other two 100 and 1000 respectively, so that they are read off like a gas meter, and thus a resistance from 1 ohm to 11,110 ohms can be read directly, and by mounting the commutator and the permanent arms of the Wheatstone bridge on one board, we get a very compact instrument, and have all the handles within easy reach for rapid change. About 7 centimetres will be found ample for the diameter of the disk, and the whole apparatus may be mounted on a board about 45 centims. long and 10 centims. wide.



Dr. Stone's results, as published in *Nature*, gave a definite direction to the idea, and then, when considering how I could carry out what I proposed, I saw that I must first have an instrument by which measurements could be rapidly made and changes easily followed, and if possible, the current should not be broken by altering the measure.

The ordinary resistance box with plugs cannot be used sufficiently rapidly and is unsuitable. I therefore adopted the plan of mounting the resistance reels on an ebonite disk, with a metal axis (a) running at each end in brass supports, s. This support has a binding screw at the base

The arrangement of resistances is much the same as in slide resistances, and the plan of arranging these in a circle has been used for medical purposes, but I am not aware of the resistances themselves being made to revolve, though I have not had any opportunity of investigating all the plans previously adopted. It seems to me, however,

* A Paper read before the Manchester Literary and Philosophical Society, January 22, 1884.

† The measurements were made for the purpose by consumptive people in Davos.

* These flanges overlap on each side and therefore present to the spring a continuous surface the width of the disk.

that in cases where only amateur or imperfect workmanship is available, that this will be found the simplest plan, and also, I think that when compactness and rapidity of action are important this form may often be found useful, and, therefore, describe it although there is no new principle involved.

One such disk may also be used when a galvanic current is being applied for medical purposes, in which case the current is made to first pass through a high resistance of several reels, and then without contact being broken the resistance is brought down to null. In such cases it may be found advisable to make the first resistance much lower than the last.

CHLORINATION OF PYROGALLOL: TRI-CHLORO-PYROGALLOL.

By C. S. S. WEBSTER, F.C.S.

This subject has been studied by Stenhouse and Groves, and the results of their investigations were published some years since (*Chem. Soc. Journ.*, 1875, 704). Recently working on this subject, in conjunction with Messrs. Cross and Bevan, and in connection with their researches upon the formation of phenol derivatives in plants, I made a closer examination of the first stage of the chlorination of pyrogallol (in solution in glacial acetic acid) noticed by the above-named chemists. I have satisfactory proof that it consists in the production of a tri-chloro derivative $C_6Cl_3(OH)_3$, which is obtained crystallising in the form of needles, with $3H_2O$.

As far as I have been able to ascertain no derivatives of this formula have hitherto been obtained.

I hope to lay a full account of my investigation before the Chemical Society, and therefore content myself at present with this bare record of its chief result.

ON THE PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Continued from page 131.)

Grape Sugar inclosed in Stomach and Intestine, and these immersed in Water for Diffusion to occur.

Experiment.—A solution of grape sugar was inclosed in the stomach of a freshly-killed rabbit which had been emptied of its contents, and thoroughly rinsed through with water. The stomach was then immersed in about 100 c.c. of water contained in a beaker, and the beaker exposed for thirty minutes to 120° F. (48·8° C.). At the end of this time a portion of the water was taken from the beaker for analysis, and the beaker and its contents were afterwards placed on one side and exposed to the ordinary temperature for twenty-four hours. The water in the beaker and the contents of the stomach were now respectively subjected to analysis. The two portions of water removed from the beaker only required to be measured, divided into two equal parts, and titrated before and after boiling with sulphuric acid, used as is always the case in the proportion to give a 2 per cent solution. The contents of the stomach were treated with crystals of sulphate of soda, boiled, filtered, and washed, and the filtrate brought to a known bulk and divided into two equal parts.

One part was titrated at once, and the other, after the process of boiling with sulphuric acid, conducted in the usual manner. Subjoined are the results yielded:—

* A Paper read before the Royal Society, Dec. 20th, 1883.

Water from Beaker at the end of thirty minutes.

Before sulphuric acid	0·012 grm.
After ,, ,, ...	0·012 ,,

Water from Beaker at the end of twenty-four hours.

Before sulphuric acid	0·086 grms.
After ,, ,, ...	0·160 ,,

Contents of Stomach at the end of twenty-four hours.

Before sulphuric acid	0·526 grm.
After ,, ,, ...	0·768 ,,

These results show that at the end of half-an-hour only a very small portion of the contents of the stomach had reached the surrounding water, and that this first diffusate consisted of unchanged glucose at the end of 24 hours, the water contained a product with cupric oxide reducing power of 53 as compared with 100 for glucose, and the contents of the stomach 67 against 100.

The intestine was used in a similar manner. Here a duplicate observation was made, and in each case a length of intestine of about 20 inches was employed. The results yielded were as follows:—

I. *Water from Beaker at the end of thirty minutes.*

Before sulphuric acid	0·016 grm.
After ,, ,, ...	0·016 grm.

Water from Beaker at the end of twenty-four hours.

Before sulphuric acid	0·208 grm.
After ,, ,, ...	0·384 ,,

Contents of Intestine at end of twenty-four hours.

Before sulphuric acid	0·415 grm.
After ,, ,, ...	0·768 ,,

II. *Water from Beaker at the end of thirty minutes.*

Before sulphuric acid	0·020 grm.
After ,, ,, ...	0·020 ,,

Water from Beaker at the end of twenty-four hours.

Before sulphuric acid	0·250 grm.
After ,, ,, ...	0·588 ,,

Contents of Intestine at the end of twenty-four hours.

Before sulphuric acid	0·454 grm.
After ,, ,, ...	0·768 ,,

In both these observations, as in the case of the stomach, the water at the end of half-an-hour contained unchanged glucose in small amount. The water at the end of twenty-four hours contained a product with the reducing power, in the one case of 54 and in the other 42 to 100 for glucose; with the contents of the intestine the glucose had been transformed so as to give a cupric oxide reducing power of 54 and 59 instead of 100.

Experiment.—20 c.c. of a solution of grape sugar were enclosed in a rabbit's stomach as in the previous experiment, and the stomach placed in a beaker containing 100 c.c. of water, and exposed to a temperature of 120° F. (48·8° C.). Water was removed from beaker at end of one hour for examination, and the beaker and the contents afterwards allowed to remain two hours longer at a temperature of 120° F. (48·8° C.), when the water and contents of stomach were taken for analysis.

The following were the results yielded:—

Water from Beaker at the end of one hour.

Before sulphuric acid	0·008 grm.
After ,, ,, ...	0·008 ,,

Water from Beaker at the end of three hours.

Before sulphuric acid	0·010 grm.
After ,, ,, ...	0·018 ,,

Contents of the Stomach at the end of three hours.

Before sulphuric acid	0·624 grm.
After ,, ,, ...	1·052 ,,

The figures show glucose in small amount in the water contained in the beaker at the end of one hour, and a product with the reducing power of 55 to 100 for glucose in the water at the end of three hours, and 59 to 100 in the contents of the stomach.

The intestine was employed in a similar way, and the results obtained stood as follows:—

Water from Beaker at the end of one hour.

Before sulphuric acid .. .. .. 0·020 grm.
After ,, ,, ... 0·022 ,,

Water from Beaker at the end of three hours.

Before ,, ,, ... 0·060 ,,
After ,, ,, ... 0·060 ,,

Contents of the Coil of the Intestine at the end of three hours.

Before sulphuric acid .. .. .. 0·554 grm.
After ,, ,, ... 1·052 ,,

It is noticeable that the water in the beaker at the end of three hours contained glucose. I hardly know how this disparity is to be explained, and must simply give the figures just as they were yielded. The product in the intestine at the end of three hours possessed a reducing power of 52 to 100 for glucose.

Experiment.—20 c.c. of a solution of grape sugar were enclosed in the cleansed stomach of a freshly-killed rabbit, and the stomach placed in a beaker containing about 100 c.c. of water, and exposed for two hours to a temperature of 120° F. (48·8° C.). On submitting the water in the beaker and the contents of the stomach to analysis at the end of this time, the following results were obtained:—

Water from the Beaker at the end of two hours.

Before sulphuric acid .. .. .. 0·044 grm.
After ,, ,, ... 0·078 ,,
Relation before and after sulphuric acid, 56 to 100.

Contents of the Stomach at the end of two hours.

Before sulphuric acid .. .. .. 0·104 grm.
After ,, ,, ... 0·204 ,,
Relation 50 to 100.

The intestine similarly treated gave the following results:—

Water from Beaker at the end of two hours.

Before sulphuric acid .. .. .. 0·040 grm.
After ,, ,, ... 0·052 ,,

Contents of the Intestine at the end of two hours.

Before sulphuric acid .. .. .. 0·104 grm.
After ,, ,, ... 0·216 ,,

Here the water in the beaker contained a product with a reducing power of 76 in relation to 100 as the reducing power of glucose, whilst the intestine contained a body with a reducing power of only 48 to 100.

Experiment.—In a like experiment to the last, with the exception that the exposure to 120° F. (48·8° C.) was one hour and a-half instead of two hours, the subjoined results were obtained:—

Water from Beaker at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·006 grm.
After ,, ,, ... 0·006 ,,

Contents of Stomach at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·142 grm.
After ,, ,, ... 0·256 ,,
Relation 55 to 100.

Duplicate observations were made with the intestine.

I. *Water from Beaker at the end of one and a-half hours.*

Before sulphuric acid .. .. .. 0·054 grm.
After ,, ,, ... 0·082 ,,
Relation 65 to 100.

Contents of Intestine at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·140 grm.
After ,, ,, ... 0·270 ,,
Relation 51 to 100.

II. *Water from Beaker at the end of one and a-half hours.*

Before sulphuric acid .. .. .. 0·062 grm.
After ,, ,, ... 0·084 ,,
Relation 73 to 100.

Contents of Intestine at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·146 grm.
After ,, ,, ... 0·270 ,,
Relation 54 to 100.

Experiment.—Two lengths, each of about 20 inches, of thoroughly cleansed rabbit's intestine were charged with 20 cub. centims. of a solution of grape sugar, placed in beakers containing 100 cub. centims. of water, and exposed for one hour to a temperature of 120° F. At the end of this time the usual analysis was performed.

I. *Water from the Beaker at the end of one hour.*

Before sulphuric acid .. .. .. 0·020 grm.
After ,, ,, ... 0·034 ,,

Contents of Intestine at the end of one hour.

Before sulphuric acid .. .. .. 0·118 grm.
After ,, ,, ... 0·172 ,,

II. *Water from Beaker at the end of one hour.*

Before sulphuric acid .. .. .. 0·020 grm.
After ,, ,, ... 0·035 ,,

Contents of Intestine at the end of one hour.

Before sulphuric acid .. .. .. 0·120 grm.
After ,, ,, ... 0·178 ,,

In these duplicate observations the results show that the water from the beaker contained a body with a reducing power in the one case of 58, and in the other of 57, as compared with glucose at 100. The contents of the intestine in each case possessed a reducing power of 68 to 100.

Situation of Converting Principle.

I at first took it for granted that the probable seat of the active principle which which had effected the transformation of glucose into a product of lower cupric oxide reducing power was in the superficial surface of the mucous layer. Uuder this impression I operated with the scrapings from the surface of the mucous membrane. The idea has proved to be erroneous, but it occasioned me for some time a considerable amount of embarrassment through the want of constancy and positiveness in my results. I generally, but not invariably, obtained a sufficiently marked effect, especially when a large quantity was used with the scrapings from stomach and intestine of the rabbit, but in the case of the other animals that I tried—pig, sheep, horse, cat, and dog—my results were such as to lead me to consider that no action which could be regarded as of physiological significance was exerted. Such a conclusion, however, was difficult to accept, for I had ascertained in some of the animals mentioned, as I shall subsequently bring forward experiments to show, that when grape sugar was introduced into the stomach it reached the portal vein not as glucose but as a body of about the cupric oxide reducing power of maltose. I have since dealt with the entire coats of the stomach and intestine of the pig, cat, and dog, used after being finely cut up with scissors, and have found marked transformative action exerted. I have not made any precise comparative observations, but from what I have seen I am under the impression that the stomach and the intestine of the rabbit act more enegetically than the stomach and intestine of the other animals I have tried. It also appears to me that the stomach acts more energetically than the intestine, and in some instances I have noticed that the effect pro-

duced has stood in relation to the amount of ferment material used.

A review of my experiments led me to take the entire walls instead of the scrapings from the inner surface, and I then obtained the results which have been already described. I have, however, tested the question experimentally by operating with the scrapings and the deeper part separately, and the results show in a decided manner where the active principle is situated. Perhaps the reason of my formerly getting positive results to the extent I did with scrapings from the stomach and intestine of the rabbit was on account of the delicacy of the structures in this animal leading to more or less of the deeper part being removed with the superficial.

Experiment.—The cleansed stomach of a recently-killed rabbit was divided into two longitudinal halves along the curvatures. One-half was used entire and after being minutely divided was placed in a beaker with about 50 cub. centims. of water. The other half was lightly scraped upon the surface, and the scrapings also placed in a beaker with a similar quantity of water. The remaining deeper portion was finely divided, and then disposed of in a like manner. Into each beaker 10 cub. centims. of a solution of grape sugar containing 0·142 grm. of glucose were placed, and the products were then exposed side by side for two hours to a temperature of 120° F. (48·8° C.).

The intestine was also at the same time dealt with in a similar way, and the subjoined figures show the results that were obtained:—

Entire Walls of the Stomach.

Before sulphuric acid	0·102 grm.
After „ „	0·134 „

Scrapings of Inner Surface.

Before sulphuric acid	0·134 grm.
After „ „	0·134 „

Part left after Removal of Inner Surface.

Before sulphuric acid	0·100 grm.
After „ „	0·134 „

Entire Walls of the Intestine.

Before sulphuric acid	0·118 grm.
After „ „	0·138 „

Scrapings of Inner Surface.

Before sulphuric acid	0·142 grm.
After „ „	0·138 „

Part left after Removal of Inner Surfac

Before sulphuric acid	0·118 grm.
After „ „	0·138 „

(To be continued.)

ON THE CONDUCT OF MOIST PHOSPHORUS AND AIR TOWARDS CARBON MONOXIDE.*

By IRA REMSEN and E. H. KEISER.

In a paper recently published† we described some experiments which led us to the conclusion that when a mixture of carbon monoxide and air is brought in contact with moist phosphorus there is no oxidation of the monoxide. This conclusion is directly opposed to that reached by Leeds‡ and by Baumann,|| according to whom the oxidation is easily effected. If these chemists are right, it follows that when moist phosphorus acts upon oxygen, something is formed which is distinct from free oxygen and from ozone. To this the name active oxygen has been given. Since our paper appeared, both Leeds§ and Baumann* have published the results of new experiments, and as we suggested that their error might be due to the action of ozone on organic substances present, such as cotton-wool, rubber, corks, &c., they have carefully avoided such contact. Leeds finds no occasion to modify in the slightest degree his first statement on the subject. Baumann, however, who has taken great care in the construction of his apparatus, and whose paper gives clear indications of accurate work, obtains results which differ in some respects from those described by him in his first paper.† In the latter, in speaking of the passage of the mixture of air and carbon monoxide over the phosphorus, he says "das vorgelegte Barytwasser wird schon nach kurzer Zeit trübe und im Laufe einer Stunde bildet sich ein reichlicher Niederschlag von kohlensaurem Baryt." In this experiment the gases were used in the proportion three volumes of oxygen to one of the monoxide. The whole description is such as to leave upon the mind of the reader the impression that the oxidation is very easily effected. In his last paper Baumann is much more cautious, and, though he still insists that the carbon monoxide is oxidised, the extent of the oxidation appears to have been much less than in the first experiments. Instead of getting an abundant precipitate (reichlicher Niederschlag), only a small one was obtained, and the formation of this required a much longer time, as appears from the following passage:—"Nach den ersten zwei Stunden zeigte sich schon eine deutliche Trübung. . . . die von da ab stetig zunahm: da der Niederschlag hauptsächlich im Innern der Zuleitungsröhre . . . abgeschieden wurde, wurde letztere nach weiteren 10 Stunden verstopft."

Another point which arrests attention when the paper is read critically is this, that in order to get evidence of oxidation, very large volumes of air mixed with a little monoxide are passed over the phosphorus. In one case 200 c.c. of the monoxide are admitted every two hours In another the author speaks of using 700 c.c. of the monoxide "in starker Verdünnung mit Luft," the passage requiring 15 hours. The amount of carbon dioxide obtained was 0·0366 grm. or 2·6 per cent of the monoxide was oxidised. In still another experiment, a mixture consisting of 30 litres of air and 2·45 litres of the monoxide occupied 12 hours in passing the phosphorus, the amount of carbon dioxide obtained being 0·0646 grm., representing the oxidation of 1·3 per cent of the monoxide.

Of course there can be no objection to using large volumes of air, provided it can be shown by blank experiments that no error is introduced in consequence, and this Baumann appears to have done. Speaking of passing air alone through the apparatus he says:—"Hält man den Luftstrom so, dass . . . in der Secunde nicht mehr als zwei bis drei Blasen hindruchtreten, so entsteht . . . auch nach mehreren Tagen nicht mehr als eine ganz leichte Trübung von phosphorsaurem resp. phosphorigsaurem Baryt."

Passing now to Leeds's new experiment, but a few words will be necessary. This writer filled a glass-stoppered 10-litre flask with a mixture of equal parts of carbon monoxide and air, and allowed the mixture to stand in contact with moist phosphorus for six days. Then the glass stopper was removed, replaced by a cork, and, the mouth of the vessel being placed under mercury, the gaces were displaced and passed through baryta water. A precipitate representing 0·0155 grm. of carbon dioxide was obtained. There is one source of error in this experiment which should be noted at once. It is clear that by standing for six days in the tightly closed vessel, the oxygen of the air must have been completely used up, so that the gases were necessarily under diminished pressure. Apparently, in taking out the glass stopper for the purpose of introducing the cork, no precautions were taken to prevent access of ordinary air, and a considerable volume of ordinary air must have entered; not enough certainly to give the quantity of carbon dioxide obtained, but enough to cause

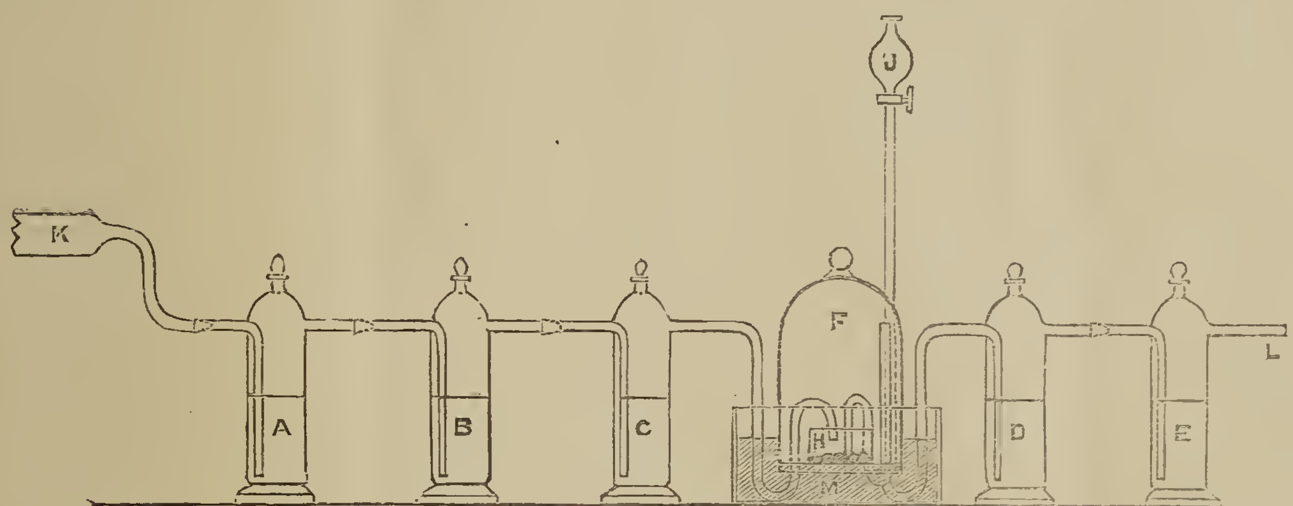
* *Amer. Chem. Journ.*, vol. v., No. 6.
† *Ibid.*, iv., 454.
‡ *Journ. Amer. Chem. Soc.*, i., 322.
|| *Zeitschrift für Physiologische Chemie*, v., 250.
§ Chemical News, xlviii., 25

* *Berichte der Deutschen Chemischen Gesellschaft*, xvi., 2146.
† *Loc. cit.*

a perceptible precipitate in the baryta water. Another source of error, however, much more serious than this, and quite sufficient to account for the result, has since been discovered by us.

Although we felt convinced of the accuracy of our first work and the correctness of the result, we have nevertheless subjected the work to a careful revision. Working with the precautions previously used, we have obtained exactly the same results as at first. On studying Baumann's paper, however, it seemed to us possible that there might be a slight oxidation, so slight as to escape notice when comparatively small volumes of the gases are used. Now, in most of our first experiments small volumes were used, and we therefore felt it incumbent upon us to go over the work, using larger volumes. We first passed thoroughly purified air through an apparatus which was so arranged as to prevent all contact of ozone with organic substances. The current was fully as slow as that in Baumann's experiments, and the gases, after passing out of the ozonising vessel, were washed with a rather larger quantity of water than was used by Baumann. A cloudiness began to appear in the baryta water after six or eight litres of air had passed through, and this increased constantly, until when 25 to 30 litres had passed in 12 to 15 hours a distinct precipitate, not a mere turbidity, was in the vessel containing the baryta water. The precipitate was carefully examined with reference to the presence of phosphorus compounds, but not a trace could be detected. The experiment was repeated with the same result. It is clear, therefore, that in spite of Baumann's explicit statement, there is some source of carbon dioxide independent of carbon monoxide, and before accurate experiments can be made this source must be discovered and if possible avoided.

Karsten* has shown that when air alone comes in contact with the organic matter of corks and connectors, carbon dioxide is formed, and that if a large volume of air is first freed from carbon dioxide and then passed through lime water, a precipitate is formed, unless all contact with organic matter is prevented. Storer† has recently confirmed this observation. It hence seemed possible that the carbon dioxide obtained from the air in our experiment might be formed either from the organic matter in the air or by the action of the air on the rubber connectors and corks of the wash bottles used in purifying it, and our next step was to so arrange our apparatus as to absolutely exclude all organic matter. This was effected by means of an apparatus illustrated in outline in the figure. The wash-bottles A, B, C, D, E, were made for us by a skilful glassblower. They are fitted with glass stoppers, and the escape tube of each fits air-tight into the entering tube of the next one by means of a ground glass joint. The tube, K, only partly represented in the figure, is about 14 inches long and of hard glass. The vessel, F, is an ordinary bell-jar, holding about one and a quarter litres. This is held in position on mercury contained in a crystallising dish. Upon the mercury floats a smaller vessel, in which the phosphorus is placed. The tube from the last wash bottle through which the air is passed before it comes in contact with the phosphorus is bent so as to pass beneath the edge of the bell-jar, then up into the closed space above the mercury, and then down towards the phosphorus. The tube through which the carbon monoxide is passed into the vessel is arranged in the same way. A long funnel tube, J, is bent in a similar way, but reaches down to the bottom of the dish containing the phosphorus. By means of it the phosphorus can be covered with water or uncovered, as may be desired, without disarranging the apparatus. The tube through which the gases pass out of the bell-jar is bent like the two already referred to, with the exception that it is not directed downward after entering the vessel, but is allowed to project nearly to the top of the space. All joints which are not of ground glass are carefully fitted by means of gypsum.



This is the apparatus exactly as it was used in a number of experiments with air alone. The method of experimenting was as follows:—The air was contained in a gasometer holding 30 litres. From this it was passed slowly, at the rate of about two or three bubbles per second, into the hard glass tube, K, containing copper oxide heated to dull redness; then through the three wash-bottles, the first two containing caustic soda and the last one baryta water. It was then passed into the bell-jar containing the phosphorus. Care was taken to keep the air in this vessel as near 24° as possible, and the white fumes indicating the action of the phosphorus were always abundant during the course of an experiment. The amount of phosphorus exposed, that is, not covered by water, varied from 20 to perhaps 70 or 80 grms., the usual amount being between 20 and 30 grms. From the bell-jar the ozonised air with whatever it contained passed through the wash-bottle, D, containing from 30 to 40 c.c. of pure distilled water, and then into the concentrated baryta water. The last bottle, E, containing the baryta water, was connected with a tube containing caustic potash to protect it from the ordinary air.

We cannot see how any exception can be taken to the apparatus used by us, or to the method of conducting the experiments. Nevertheless, working under what appear to us to be perfect conditions, we obtained exactly the same result as we had obtained in the first experiments with air, viz., the air alone when passed for a sufficient length of time gave a precipitate in the last bottle. Ten litres of air always cause a distinct turbidity, and twenty to thirty give a precipitate. As there was no possible source of error, it follows that the carbon dioxide obtained must have come from carbon contained in the phosphorus. There is no escape from this conclusion. That there should be carbon in phosphorus is not surprising when we consider the method of manufacture; and the fact that

* *Poggendorff's Annalen*, cxv., 348.
† *Amer. Chem. Journ.*, v., 69.

boron, silicon, iron, &c., which are made by similar methods, all contain small quantities of this element. Indeed the presence of carbon in the phosphorus as it is at first obtained is well known, and, in the purification process adopted, chromic acid is used for the purpose of removing it. *A priori* we would hardly expect the process of purification to be complete, and our experiments furnish the proof that it is not.

Whether the carbon is present in the phosphorus in chemical combination or not is a question difficult to answer. We can only say that the phosphorus used by us appeared to be perfectly homogeneous. There was no evidence of the presence of particles in it. Its solution in carbon bisulphide was clear, and on standing nothing whatever was deposited. Some of the phosphorus which we used had been carefully re-distilled by us. This made no difference in the result. These facts lead us to believe that the carbon is in chemical combination with the phosphorus.

We have made some attempts to estimate the quantity of carbon present, but have not been successful. A simple way to show its presence is to burn a piece of phosphorus in a small porcelain dish floating on water under a bell-jar fitted with a glass stopcock. After the combustion is over, the vessel is allowed to stand for some time until the white fumes have entirely disappeared. The gas is then passed through water, and finally into baryta water, where a not insignificant precipitate is invariably formed. The air in the bell-jar must, of course, be purified. As the vessel is lifted only far enough to permit the introduction of the dish with the phosphorus, and this operation is performed instantaneously, the amount of carbon dioxide introduced with the air can be only infinitesimal.

The complete oxidation by means of chromic acid of a weighed quantity of phosphorus, and estimation of the carbon dioxide formed, gave unsatisfactory results, for the reason that it was impossible to regulate the action and at the same time secure complete oxidation of the phosphorus. With concentrated solutions the action is liable to become very violent unless the temperature is kept low. By means of the experiments with chromic acid we were able to demonstrate the presence of the carbon by the formation of a precipitate of barium carbonate; but though the precipitate was weighed in a few cases, the results are of little value, as the action was evidently incomplete.

Similar experiments with nitric acid were equally unsuccessful as quantitative analyses, though they also clearly showed the presence of carbon.

Finally an apparatus was arranged similar to that used for making phosphorus pentoxide on the small scale. The combustion was effected in pure air, and after being thoroughly washed the gases were passed through baryta water. Again a precipitate was formed, but the operation was far from perfect, owing to the formation of a considerable quantity of red phosphorus, and to imperfect oxidation.

For the present we have given up the attempt to estimate the quantity of carbon in phosphorus, and content ourselves with having proved beyond question that it is present in sufficient quantity to interfere with such delicate experiments as those upon the oxidation of carbon monoxide.

We now made some experiments with the object of determining how far changes in the amount of phosphorus exposed in the ozoniser perceptibly changed the amount of barium carbonate formed. We found that the amount of the precipitate is plainly influenced by the rate of passage of the gases, the temperature, and the amount of phosphorus exposed, but that, if the temperature is between 20° and 25°, the rate of passage of the air about two or three bubbles per second, and the amount of phosphorus exposed from 20 to 30 grammes, a slight precipitate is always formed by 10 litres of air, and that 25 to 30 litres give a very decided precipitate.

It does not of course follow, from the facts above described, that carbon monoxide is not oxidised by air in the presence of moist phosphorus, but it is clear that in experiments undertaken for the purpose of deciding the question allowance must be made for the presence of carbon in the phosphorus. The amount of allowance to be made cannot be determined with accuracy, for the amount of phosphorus exposed cannot be perfectly controlled in the apparatus used. The best way to reach a positive conclusion is to perform parallel experiments under as nearly the same conditions as possible, one with air alone, the other with air and carbon monoxide. If the vessels in which the precipitates are formed are of the same shape and size, and each contains the same amount of baryta water, we can judge with a fair degree of accuracy whether a larger precipitate is formed in one case than the other.

In making these comparisons about 25 litres af air were first passed through the apparatus, the conditions being carefully noted. The bottle containing the precipitate formed was removed at the end of the operation, instantly stoppered and placed aside for comparison. The water was then removed from the wash-bottle and replaced by fresh distilled water, a new bottle attached in the place of E, and, after passing about a litre of pure air through the apparatus, the necessary quantity of baryta water filtered rapidly through a plaited filter into the wash-bottle. Now the experiment was repeated with the difference that during the passage of the 25 litres of air, a very slow current of carefully purified carbon monoxide (made from pure sulphuric and formic acids) was passed through three wash-bottles like those used for the air and containing the same substances, and then, through the tube described above, brought into the presence of the phosphorus and air. The rate of the current was so regulated that, during the time of the experiment, which varied in different cases from three to eight hours, 3 litres of the monoxide were used. The same slow formation of a precipitate was noticed when the carbon monoxide was used as in the case of air alone. At the end of the operation we were unable to distinguish any difference between the amounts of the small precipitates formed. In neither case did this amount appear to be as great as that found by Baumann. The precipitates were too small to permit of accurate filtering and weighing, if we consider the nature of the liquid in which they were present. Comparing their size with that of certain larger precipitates which we did weigh, we estimated that they could not possibly weigh more than 1 to 2 m.grms. If there was any difference between them it could not have amounted to more than a small percentage of the total weight, and, as already said, no difference was apparent. The only conclusion which we can draw is, as we claimed in our first publication on this subject, that carbon monoxide is not oxidised by air in the presence of moist phosphorus.

The precipitate obtained by Leeds, which he ascribed to oxidation of the carbon monoxide, must have been due mainly to the oxidation of the carbon in the phosphorus. We have shown that the amount of carbon dioxide formed by burning phosphorus in a few litres of pure air is considerable; quite enough, we should judge, to give a precipitate as large as that obtained by Leeds.

The fact that Baumann obtained precipitates when working with large volumes of air is easily understood; but that they should have been as large as they were is not easily explained. That only a slight turbidity should have been obtained after several days, on passing air alone through the apparatus, is beyond our comprehension.

That in our first experiment we should have obtained no evidence of the presence of carbon is due to the fact that we worked with small volumes of the gases. In those cases in which relatively large volumes were used the slight cloudiness produced was disregarded, as the same result was obtained with air alone. We are further inclined to think that the moist asbestos through which the gases were passed may have retained a small quantity of the carbon dioxide. We have found that this method of

filtering is quite superfluous, and that the water in the small wash-bottle is sufficient to retain all traces of phosphorus compounds. Phosphorus could never be detected in the precipitate of barium carbonate, and indeed, when the current was as slow as usual, phosphorus compounds were not found in the first wash-bottle.

Although our experiments have cost us a great deal of time and labour, the apparatus finally used is simple and the experiments may be repeated with comparatively little trouble. We therefore hope that others who may be interested in the subject may find the time to repeat them. It is however, absolutely necessary that all the precautions mentioned by us be taken.

It certainly appears remarkable that carbon monoxide is not oxidised by air in the presence of moist phosphorus where the formation of ozone is constantly taking place. If our ordinary conceptions in regard to this process are correct, the phosphorus splits up the molecules of oxygen and unites with some of the atoms thus set free, while other oxygen atoms rearrange themselves in the form of ozone molecules. There should, according to this conception, be free atoms of oxygen in the immediate vicinity of the phosphorus, and the first thought would naturally be that an unsaturated compound like carbon monoxide must be oxidised. That it is not is, however, quite in accordance with its conduct towards ozone during the transformation of the latter into ordinary oxygen. One of us (R.) has shown* that, if carbon monoxide be mixed with ozone, and the mixture passed through a tube heated to about 300°, a temperature sufficiently high to transform all the ozone into oxygen, no oxidation of the monoxide takes place. In this experiment we have conditions exactly the opposite of those involved in the phosphorus experiment. In both cases, however, according to the prevailing notions, free atoms of oxygen ought to be formed and to exist in the interval, however brief it may be, between the breaking up of the ozone and the formation of oxygen or the splitting up of the molecules of oxygen and the formation of ozone.

Why carbon monoxide is not oxidised by ozone itself under ordinary circumstances is a question which it is impossible to answer in the present state of our knowledge; still less can we imagine a reason for the fact that it is not oxidised by the gases formed when ozone is broken up by heat, nor by those formed during the production of ozone by the action of phosphorus on moist air.

There is at present then only one experiment on record which seems to show that by starting with ordinary oxygen this can be so changed as to acquire the power to oxidise carbon monoxide at lower temperatures. This is the experiment of Baumann† with palladium hydrogen. In view of the fact that Traube has shown that palladium‡ and hydrogen dioxide together can readily oxidise the monoxide, an observation which we have confirmed,|| and that hydrogen dioxide is formed, though apparently in small quanity, by the action of palladium hydrogen on air and water, the question as to the cause of the oxidising action of palladium hydrogen may fairly be regarded as an open one.

The observation of Leeds that when a mixture of carbon monoxide and air is submitted to the silent electrical discharge carbon dioxide is formed, furnishes no evidence of the formation of active oxygen, as Andrews and Tait§ have called attention to the fact that when the silent discharge acts upon carbon monoxide alone some dioxide is formed.

A Gas Burner giving a White Light by the Incandescence of Magnesia.—Ch. Clamond.—The author's arrangement with a consumption of 180 litres of gas per hour give a light equal to 4 carcels.—*Comptes Rendus.*

* *Amer. Chem. Journ*, iv., 50.
† *Zeitschrift fur Physiologische Chemie*, v., 250.
‡ *Berichte der Deutschen Chemischen Gesellschaft*, xv., 2854.
|| *Amer. Chem. Journ.*, iv., 454.
§ *Philosophical Transactions*, 1860, p. 126.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

GOLD.

The only determinations of the atomic weight of gold which are worthy of consideration are those of Berzelius and of Levol.

The earliest method adopted by Berzelius† was that of precipitating a solution of gold chloride by means of a weighed quantity of metallic mercury. The weight of gold thus thrown down gave the ratio between the atomic weights of the two metals. In the single experiment which Berzelius publishes, 142·9 parts of Hg precipitated 93·55 of Au. Hence, using the value for mercury given in a preceding chapter, 199·712, Au = 196·113.

In a later investigation‡ Berzelius resorted to the analysis of potassio-auric chloride, $2KCl.AuCl_3$. Weighed quantities of this salt were ignited in hydrogen; the resulting gold and potassium chloride were separated by means of water, and both were collected and estimated. The loss of weight upon ignition was, of course, chlorine. As the salt could not be perfectly dried without loss of chlorine, the atomic weight under investigation must be determined by the ratio between the KCl and the Au. If we reduce to a common standard, and compare with 100 parts of KCl, the equivalent amounts of gold will be those which I give in the last of the subjoined columns:—

Grms. K_2AuCl_5.		Grm. KCl.		Grms. Au.	
4·1445	gave	0·8185	and	2·159	263·775
2·2495	,,	0·44425	,,	1·172	263·815
5·1300	,,	1·01375	,,	2·67225	263·600
3·4130	,,	0·674	,,	1·77725	263·687
4·19975	,,	0·8295	,,	2·188	263·773

Mean 263·730 ± 0·026

Hence Au = 196·186 ± 0·101.

Still a third series of experiments by Berzelius|| may be included here. In order to establish the atomic weight of phosphorus he employed that substance to precipitate gold from a solution of gold chloride in excess. Between the weight of phosphorus taken and the weight of gold obtained, it was easy to fix a ratio. Since the atomic weight of phosphorus has been better established by other methods, we may properly reverse this ratio and apply it to our discussion of gold. 100 parts of P precipitate the quantities of Au given in the third column:—

0·829 grm. P precipitated	8·714 Au.	1051·15
0·754 ,,	7·930 ,,	1051·73

Mean 1051·44 ± 0·196

Hence Au = 195·303 ± 0·589.

Levol's§ estimation of the atomic weight under consideration can hardly have much value. A weighed quantity of gold was converted in a flask into $AuCl_3$. This was reduced by a stream of sulphur dioxide, and the resulting sulphuric acid was determined as $BaSO_4$. 1 grm. of gold gave 1·782 grms. $BaSO_4$. Hence Au = 195·794.

If we give this single experiment and Berzelius's single result with mercury each equal weight with one analysis in the potassio-auric chloride series, and include respectively the probable errors appertaining to Hg and to $BaSO_4$, we may combine all the data as follows:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 177.
‡ *Lehrbuch*, 5 Aufl., 3, 1212.
|| *Ibid.*, 5th Aufl., 3, 1188.
§ *Ann. d. Chim. et d. Phys.*, (3), 30, 355. 1850.

From KCl: Au ratio	Au = 196·186	± 0·101
„ Hg: Au ratio	„ 196·113	0·335
„ P: Au ratio..	„ 195·303	0·589
„ $BaSO_4$: Au ratio.. ..	„ 195·794	1·234
General mean..	„ 196·155	0·095

Or, if O = 16, Au = 196·606.

As gold is a metal which can be readily applied to the determination of the atomic weights of other elements, an experimental revision of its atomic weight is very desirable.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 20, 1884.

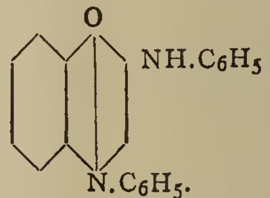
Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—W. D. Borland, A. F. Dimmock, J. Gaskell, W. H. Perkin (jun.), A. G. Perkin, J. W. Pratt.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Drs. P. Frankland and Morley, duly elected Fellows:—F. W. Brown, H. Cave, F. W. Fleming, E. E. Graves, A. E. Lewis, J. E. London, G. A. Parkinson, S. Smith, G. Tunbridge, T. U. Walton.

Mr. Tribe then read a "*Note on the Preparation of Marsh-Gas*," by J. H. Gladstone and A. Tribe. In 1873 (*Chem. Soc. Journ.*, xi., 682) the authors described two reactions in which marsh-gas was produced free from other hydrocarbons by the action of the copper-zinc couple on methyl-iodide in the presence of water or alcohol. The loss of methyl-iodide was, however, considerable, varying from 23 to over 50 per cent. In the present note the authors describe a slight modification of the apparatus, by means of which this loss can be prevented. About 600 grms. of thinly granulated zinc are immersed in a 2 per cent solution of copper sulphate until the latter is decolourised. The copper-zinc couple is washed with water, and finally with alcohol. It is introduced into a flask, the mouth of which is closed by a doubly-perforated cork. Through the cork pass the end of a stoppered funnel containing the methyl-iodide, and the end of an upright wide glass tube 12 ins. long and 1 in. in internal diameter, filled with copper-zinc couple. The upper end of this tube is also closed by a doubly-perforated cork, into which fit a delivery-tube and the end of a stoppered funnel containing alcohol. This upright tube serves the double purpose of a copper-zinc scrubber and an inverted condenser. A mixture of 20 c.c. of alcohol and 20 c.c. of methyl-iodide being allowed to run into the flask, a steady evolution of marsh-gas proceeds. The first litre was evolved in eight minutes. 7053 c.c. were obtained, the theoretical yield being 7100 c.c. The reaction can be much expedited by gently heating the flask.

The Secretary then read a paper "*On the Action of Dibrom-a-Naphthol upon Amines*," by R. Meldola. In a preliminary note (Chemical News, vol. xlvii., p. 27) the author called attention to the remarkable facility with which dibrom-α-naphthol entered into reaction with certain amines, forming, in the case of aniline, para-toluidin and β-naphthylamin, well characterised crystalline bases. The action of this dibrom-naphthol upon diamines has been made the subject of a patent by L. Casella and Co. (German Patent No. 20850), and the reaction has been investigated by R. Möhlau (*Berichte*, 1883, 2853). The author therefore confines himself to a description of some results of the action of dibrom-α-naphthol upon monamines. On mixing dibrom-α-naphthol with about three times its weight of aniline, a white crystalline mass of aniline-dibrom-naphtholate is formed. On heating to nearly the boiling-point of aniline the contents of the flask acquire a deep reddish-brown colour: the reaction is complete in about ten minutes; when cool the mass forms a solid cake of crystals. The substance was purified by washing and re-crystallisation from boiling alcohol, and formed orange-red needles melting at 179°. It possessed basic properties, and agreed with the diphenyl-di-imido-naphthol of Goes and Zincke. The zinc and platinum salts were prepared and analysed, and the identity of the substance with β-naphtho-quinon-dianilide conclusively established. With ortho-toluidin a similar reaction took place, but nothing separated out on diluting the contents of the flask with alcohol. With para-toluidin similar results were obtained, and the product crystallised out in silky orange needles, melting at about 175°. A crystalline body was also formed when naphthylamine was used. The action of dibrom-α-naphthol upon amines therefore furnishes a most simple method of obtaining these quinone-imide derivatives in large quantities. The author then discusses the significance of this production, as affording an insight into their constitution, and considers that the constitution of β-naphtho-quinone-dianilide must be—



The Secretary then read "*A Note on the Existence of Salicylic Acid in the Cultivated Varieties of Pansy and in the Violaceæ generally*," by A. B. Griffiths and E. C. Conrad. The authors have extracted colourless acicular crystals from pansy leaves, &c., soluble in ether, alcohol, and boiling water, which gave with ferric chloride a violet colour. A combustion gave numbers agreeing with the formula of salicylic acid. The leaves yielded 0·13 per cent, the stems 0·08 per cent, the roots 0·05 per cent, whilst the flowers contained only a trace. The authors cut sections of the leaves, &c., but failed to discover any crystals of salicylic acid in the cells.

The Society then adjourned to April 3. The Anniversary Meeting will be held March 31.

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, March 22, 1884.

Prof. F. Guthrie, President, in the Chair.

The President announced that a meeting of the Society would be held on May 10, at Birmingham, by invitation. The next meeting will be on April 26.

Professor S. P. Thompson then read a paper by himself and Mr. C. Starling, "*On Hall's Phenomenon.*" The authors had not agreed with Hall's explanation of his observed effect, and last year undertook experiments to investigate its nature. They employed a strip of tin-foil gummed on a mahogany board with vaseline, which being soft and a non-conductor answered well for this purpose. A top-shaped electro-magnet with a pointed pole was used on one side of the strip to try the effect of a pointed pole. The current was obtained from accumulators. They found that the equipotential lines in the strip, which before magnetisation ran straight across the strip, were slightly curved on either side of the pointed pole after magnetisation. This curving was interpreted as a reduction of resistance in the strip at the pole, and subsequent tests of the resistance of the strips in a magnetic field confirmed this view. Iron strips, however, showed a slight *increase* of resistance. It was also found that an effect similar to Hall's was got by placing the pointed pole so that this change of resistance was not symmetrical with respect to the points in the strip to which the galvanometer was con-

nected. But inasmuch as this effect was not reversible by reversing the magnetism, it was not Hall's effect which they failed to obtain with the narrow pointed pole. In their experiments thermo-electric results were eliminated, and their results, though different, do not clash with those of Mr. Bidwell.

A Paper by Mr. Herbert Tomlinson on the same subject was read by Professor Reinold. The author drew attention to a similarity between Hall's table of results and one of his on the effects of mechanical stress on electrical resistance.

Mr. Shelford Bidwell read a note on "*Hall's Effect in Tin*," in which he showed that a small extension and a greater extension produced opposite thermo-electric effects in tin wires.

In answer to Professor Guthrie and Mr. Walter Bailey, Professor Thompson stated that the change of resistance he had observed was sub-permanent, and died away in about half an hour. He believed it to be producible on the strip when no current traversed it.

Professor S. P. Thompson then read a Paper "*On some Propositions in Electro-magnetics*," giving a connected series of explanations throwing light on the laws of electro-magnetics, and based on a practical experiment.

ROYAL METEOROLOGICAL SOCIETY.

The usual monthly meeting of this Society was held on Wednesday evening, the 19th inst., at the Institution of Civil Engineers, Mr. R. H. Scott, F.R.S., President, in the chair. Messrs. W. Bailey, M.A., W. L. Blore, A. L. Ford, H. Leupold, A. F. Lindemann, F.R.A.S., and Rev. E. B. Smith were elected Fellows of the Society.

The President read a Paper entitled "*Brief Notes on the History of Thermometers*." He stated that the subject had been handled in a comprehensive manner by M. Renou a few years ago in the Annuaire of the French Meteorological Society, so that he should merely mention some of the leading points. The name of the actual inventor of the instrument is unknown. The earliest mention of it, as an instrument, then 50 years old, was in a work by Dr. R. Fludd, published in 1638. Bacon, who died in 1636, also mentions it. The earliest thermometers were really sympiezometers, as the end of the tube was open and plunged into water, which rose or fell in the tube as the air in the bulb was expanded or contracted. Such instruments were of course affected by pressure as well as temperature, as Pascal soon discovered. However, simultaneously with such instruments, thermometers with closed tubes had been made at Florence, and some of these old instruments were shown at the Loan Collection of Scientific Apparatus at South Kensington in 1876. They are in the collection of the Florentine Academy, and in general principle of construction they are identical with modern thermometers. Passing on to the instrument as we now have it, Mr. Scott said that most of the improvements in construction in the earliest days of the instrument were due to Englishmen. Robert Hooke suggested the use of the freezing-point; Halley, the use of the boiling-point and the employment of mercury instead of spirit, and Newton was the first to mention blood-heat. Fahrenheit was a German by birth, but was a *protégé* of James I., and died in England. Réaumur's thermometer, in its final form, owes its origin to De Luc; while the centigrade thermometer, almost universally attributed to Celsius, was really invented by Linneus. Celsius's instrument had its scale the reverse way, the boiling-point being 0° and the freezing-point 100°. Mr. Scott then gave a brief account of some of the principal forms of self-registering and self-recording thermometers.

After the reading of this paper the meeting was adjourned, in order to afford the Fellows and their friends an opportunity of inspecting the Exhibition of Thermometers and of Instruments recently invented. This Exhibition was a most interesting one and embraced 136 exhibits. The thermometers were classiffed as follows:—(1) Standard, (2) Maximum, (3) Minimum, (4) Combined Maximum and Minimum, (5) Metallic, (6) Self-recording, (7) Solar Radiation, (8) Sea, (9) Earth and Well, (10) Thermometers used for special purposes, (11) Thermometers with various forms of bulbs, scales, &c., and (12) Miscellaneous Thermometers. In addition to these there were also exhibited various patterns of thermometer screens, as well as several new meteorological instruments, together with drawings, photographs, &c.

CORRESPONDENCE.

ON A HITHERTO UNNOTICED CONSTITUENT OF TOBACCO.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xlix., p. 123, you published an abstract of my paper on "A hitherto unnoticed Constituent of Tobacco." I shall be obliged if you would insert the following remarks:—

The acid I found in tobacco is caffetanic acid, from which, by boiling with dilute hydrochloric acid, I obtained another acid, which I called tabaco-tannic acid. The latter body does not exist ready formed in tobacco. It does not give a green colouration with ammonia, but a fine red violet, a change which is due to oxidation. Its other reactions are equally distinct.—I am, &c.,

T. J. Savery, F.I.C.

25, Huntley Street, W.C.,
March 19, 1884.

A WARNING.

To the Editor of the Chemical News.

Sir,—Some time ago a German Swiss visited Dublin, asking for employment in a chemical laboratory, and as he was in apparent distress he obtained loans of money to enable him to go over to Glasgow. I have a specimen of his handwriting: the name which he gave me was Heinrich Valtier, and he represented himself as the son of Professor Carl Valtier, of Zürich. He promised to write to me on his arrival in Glasgow, but as I have not heard I am under the impression that he is probably the same person described by Mr. Henry S. Billing.—I am, &c.,

W. N. Hartley.

Royal College of Science for Ireland,
Stephen's Green, Dublin.
March 22, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Acadême des Sciences. Vol. xcviii., No. 4, January 28, 1884.

Remarks on the Law of Faraday and on the Law discovered by M. Bouty.—M. Wurtz.—The author controverts the opinion of M. Berthelot that the interpretation of these laws becomes more obscure and more complicated if expressed by means of atomic weights as contradistinguished from equivalents.

The Dissemination, the Assimilation, and the Determination of Phosphoric Acid in Arable Soils.—P. de Gasparin.—The proportion of phosphoric acid in

rocks varies from 3 per cent in lavas to a minimum of 2 per 1000 in certain granites and certain neocomian limestones. One of the most active agents in the decomposition of rocks, and their conversion into arable soil, is the attack of their surface by mosses and lichens. Without doubt the addition of soluble phosphate accompanied with organic matter is of great value, but the presence of organic matter is the capital point, and those who think they can dispense with it indulge in chimeras. The author gives the preference to the molybdic method for determining phosphoric acid in soils. He attacks the sample of earth in the moist way, with aqua regia or hydrochloric acid in excess. The liquid is treated with ammonia cautiously, so that the sesquioxides may be precipitated before the liquid shows an alkaline reaction. The solution is then saturated with ammonia and filtered. The sesquioxides collected on the filter retain absolutely the whole of the phosphoric acid. The precipitate is ignited for the first time along with the filter in a platinum crucible. The residue, reduced to an impalpable powder, is again ignited to white redness in a small platinum crucible. This powder is then digested with nitric acid diluted to one-fiftieth. The filtrate, after concentration on the water-bath, is precipitated with the molybdic solution. After twenty-four hours the whole is filtered, and after washing with the reagent the phospho-molybdate remains absolutely pure. It is then re-dissolved in ammonia, and is precipitated with magnesia mixture.

Reciprocal Action of Two Electrised Spheres.—M. Mascart.—A mathematical paper not capable of useful abstraction.

The Skrivanow Battery.—D. Monnier.

Variations of Electromotive Force in Accumulators.—E. Reynier.—In the three systems of accumulators studied—the lead, the copper, and the zinc amalgam—the secondary electromotive force is notably higher during the charge than during the discharge. The transitory super-elevation of the electromotive force augments with the intensity of the charging current and with the electromotive force of the source. In Planté's accumulator the electromotive force is at least 1·95 volts during the charge, and at most 1·85 volts during the discharge. The coefficient of decrease is, under the most favourable conditions, 0·95. In the copper accumulator this coefficient is 0·87, and in that of amalgamated zinc 0·983. In practice the losses will be always greater.

New Means of Preparing Barium Permanganate.—G. Rousseau and B. Bruneau.—The authors decompose a cold saturated solution of potassium permanganate with hydrofluo-silicic acid, filter through asbestos, and saturate the filtrate with milk of baryta. They think that most of the permanganates may be prepared in an analogous manner.

Nitrogenous Colloid derived from Amido-benzoic Acid.—E. Grimaux.—The author has succeeded in preparing a nitrogenous colloid substance, approaching the albumenoids in its reactions, and which furnishes solutions coagulable by heat. He dissolves in ammonia the white powder formed by the action of phosphorus perchloride upon amido-benzoic acid. This solution, which filters very slowly, is evaporated in a vacuum at common temperatures. It then forms at first a thick jelly, and then dries up into translucid, yellowish, scentless, and tasteless plates, resembling blood albumen. It swells up in cold water and gradually dissolves, but is readily soluble in hot water. It may be heated to 100° without losing its insolubility in water; but if it is evaporated on the water-bath the residue, though retaining the same appearance, is quite insoluble in water, though soluble in ammonia, the alkalies, and in sodium phosphate. Hydrochloric, nitric, tartaric, oxalic, and acetic acid precipitate it; acetic acid in excess slowly re-dissolves the precipitate formed at first, and the solution deposits flocks on the addition of potassium ferrocyanide. If lime-water is added to the solution of the colloid the solution remains limpid, but it has acquired the property of coagulating to a thick jelly by the action of heat. Rennet coagulates the solution of this artificial colloid in the same manner as caseine.

The Lutidine of Coal-Tar.—Oechsner de Coninck.—There is in coal-tar a lutidine identical with one of the lutidines of Dippel's oil and with that which Ladenburg has lately formed synthetically, and which he considers as a γ-ethyl-pyridine.

No. 5, February 4, 1884.

Faraday's Law.—M. Berthelot.—The author contends that Faraday's law may be expressed in general terms more simply by means of equivalents than of atomic weights, and this as well for the electro-positive as the electro-negative elements.

Formation-Heat of Mercury Oxychlorides.—G. André.—This paper does not admit of useful abridgment.

Liquefaction of Hydrogen.—S. Wroblewski.—The author subjected hydrogen to a pressure of 100 atmospheres in a glass tube, arranged perpendicularly, of 2 m.m. external diameter, and of 0·2 to 0·4 m.m. internal diameter. By means of a screw the compressed gas can be released instantaneously. The tube was surrounded with liquid oxygen and refrigerated by means of a series of ebullitions of this body. At the moment of releasing the hydrogen there appeared in the tube an ebullition quite analogous to that observed by M. Cailletet in oxygen in his experiments in 1882. The phenomenon is produced in the same manner at a certain distance from the bottom of the tube. It lasts for a much shorter time is less decided and much less easy to perceive. The reason of this difficulty may perhaps be explained by the very low density of liquid hydrogen. MM. Cailletet and Hautefeuille in their researches on the densities of oxygen, hydrogen, and nitrogen liquefied in presence of a liquid without chemical action upon these elementary bodies, have inferred for liquid hydrogen the number 0·033. Since the same method yielded, under the same conditions, the number 0·89 for the density of oxygen, and since this latter number agrees entirely with the author's direct determinations, it may be admitted that the density assigned by MM. Cailletet and Hautefeuille for hydrogen will not be far from the truth. On the other hand, gaseous hydrogen reaches this same density, 0·033, at a low temperature, under inconsiderable pressures. Hence arises the optical difficulty of distinguishing the liquid from the gaseous portions of the hydrogen. This difficulty has probably prevented the author from reproducing M. Cailletet's experiment on hydrogen. The analogy between the phenomenon described and those presented by oxygen permits us to suppose that the temperature necessary for the complete liquefaction of hydrogen is not far from that which may be obtained by means of boiling oxygen.

MEETINGS FOR THE WEEK

Monday, Mar. 31st.—Medical, 8.30.
— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S.
Tuesday, April 1st.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
— Society of Arts, 8. "The Rivers Congo and Niger Entrances to Mid-Africa," by Robert Capper.
Wednesday, 2nd.—Society of Arts, 8. "The Dwellings of the Poor of Great Cities," by Elijah Hoole.
— Geological, 8.
— Pharmaceutical, 8.
Thursday, 3rd.—Royal, 4.30.
— Chemical, 8.
— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
Friday, 4th.—Royal Institution, 8. "The Building of the Alps," by Prof. Bonney, at 9.
— Geologists' Association.
Saturday, 5th.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1271.

ON THE USE OF MOIST ELECTRODES.

By W. N. HARTLEY, F.R.S.E., &c.
Professor of Chemistry, Royal College of Science, Dublin.

IN the CHEMICAL NEWS, vol. xlix., p. 117, I have observed a note by Prof. E. Wiedemann commenting upon the cause to which I assign the lengthening of metallic lines when spectra are taken from sparks passing between electrodes, one of which is partly immersed in water. He believes my explanation is not quite exact, and proposes one which I originally embodied in my paper, but rejected after twelve-months' consideration as on the whole unsatisfactory. The amount of oxy-hydrogen gas produced in the spark seems insufficient to make such changes in the spectra as I have noted. By heating the electrodes we lower the potential necessary to produce an intense spark, and by preventing them from becoming heated we prevent the potential from being lowered. Electrodes in air always become heated unless they are kept constantly moist or nearly immersed in some liquid such as a saline solution, water, or acid. As a rule, electrodes which are bad conductors become the hottest and yield the shortest lines, with least emissive power, as, for instance, iridium and platinum. It is the lines of iridium in which the lengthening is most remarkable when the electrodes are moistened.

SOME REMARKS ON THE DETERMINATION OF HARDNESS IN WATERS.

By HERBERT JACKSON.

HAVING had occasion some short time ago to examine a hard water which owed half its hardness to salts of magnesium, I noticed that the soap test applied in the usual way gave a result which differed very much from that obtained by the quantitative estimation of calcium and magnesium. A perfectly normal lather was obtained when soap had been added in quantities sufficient to neutralise 14° of hardness, whereas the water contained salts of calcium and magnesium equivalent, on Clark's scale, to a hardness of 27°.

Although I was aware that similar observations had been made before, I thought that it might be useful to determine the conditions under which the soap test could not be depended upon for reliable results.

I found with waters containing calcium or magnesium alone that, whenever salts of either of these metals were in solution in quantities sufficient to give 23° of hardness on Clark's scale, no dependence could be placed upon the results given by the soap test. In the case of waters containing salts of both calcium and magnesium I found that if the salts of the latter metal were in solution in quantities sufficient to give more than 10° of hardness, no evidence could be obtained of their presence so long as the salts of calcium in the same water exceeded 6°; in such a case a perfect and permanent lather was produced when soap had been added equivalent to 7° of hardness.

If any water be diluted so as to reduce the proportions of the salts of calcium and magnesium below those stated above, perfectly reliable results will of course be obtained.

Instead of dilution I found that heating the water to about 70° C. was sufficient to cause a complete reaction between the soap and the salts of calcium and magnesium, even if these were present in far larger quantities than any given here.

The experiments so far had all been made with a solution of Castile soap of the strength suggested by Mr. Wanklyn in his book on "Water Analysis." My attention was next directed to the use of any one of the compounds of which such a soap is composed. I commenced with sodium oleate, and found that by employing this substance in a moderately pure condition, perfectly reliable results could be obtained in very hard waters without the trouble of either diluting or heating. I was unable to try sodium stearate directly because of the slight solubility of this substance in cold water or dilute alcohol; but I found that a mixture of sodium oleate and stearate behaved in exactly the same manner as the Castile soap.

I am not prepared at present to state the exact reaction which takes place between salts of calcium and magnesium and a compound soap containing sodium oleate and stearate. I publish these results because I have not noticed anywhere the fact that some waters show a greater hardness with soap when their temperatures approach the boiling-point than they do at the average temperature of the air, it being, I believe, the ordinary impression that cold water wastes more soap than hot water before a good and useful lather can be obtained, whereas with very many waters the case is quite the reverse. Neither am I aware at present whether it is well known that the use of sodium oleate unmixed with sodium stearate dispenses with the process of dilution even in very hard waters.

HERDERITE, A CALCIUM AND GLUCINUM PHOSPHATE AND FLUORIDE.*

By J. B. MACKINTOSH, E.M.

A FEW weeks ago, Mr. W. E. Hidden, of Newark, N.J., brought me some specimens of a mineral from the topaz locality at Stoneham, Maine, which, from its crystallographic relations, and from its physical properties, he determined to be the rare mineral Herderite. A specific gravity determination and qualitative test for phosphorus confirmed his conclusion, and as the mineral had never been analysed quantitatively, I undertook to make the analysis.

Herderite is mentioned in all authorities as being an alumina, lime, phosphate, and fluoride, but the results of my analysis show that there is no alumina present, the mineral being a glucina, lime, phosphate, and fluoride, represented by the formula:—

$$(3CaO,P_2O_5+3GlO,P_2O_5+CaF_2+GlF_2).$$

The results obtained are:—

	Found.	Calculated for $(3CaO,P_2O_5+3GlO,P_2O_5+CaF_2+GlF_2)$
CaO	33·21	34·33
GlO	15·76	15·39
P_2O_5	44·31	43·53
F	11·32	11·64
	104·60	104·89
Less O	4·76	4·89
	99·84	100·00

The glucina was identified as such, both by its equivalent weight and by its reactions in the wet way when separated from the other constituents of the mineral.

These results are of interest as being the first recognised case of the occurrence of glucina in any other form of combination except silicates and aluminates.

If the original qualitative analysis of herderite was correct in respect to the presence of alumina, then this mineral will be a new species; the probability, however, is that the qualitative analyst was mistaken, and that this mineral is herderite.

Further details regarding this mineral will be found in *he American Journal of Science* for February, 1884.

* From the *School of Mines Quarterly*, Jan., 1884.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING FEBRUARY 29TH, 1884.

By WILLIAM CROOKES, F.R.S.
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, March 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from February 1st to February 29th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 175 samples of water, the whole were, without exception, clear, bright, and well filtered.

In respect to their degree of freedom from organic matter, the condition of the samples examined during the month has been on the whole excellent—and exceptionally so for the season of the year. In one sample only was the proportion of organic carbon at all excessive; while the mean amount afforded by the samples of Thames-derived water was 0·14 part in 100,000 parts of the water, corresponding to about two-tenths of a grain of organic matter in a gallon.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

PREPARATION OF ZINC FREE FROM ARSENIC.

By F. STOLBA.

ZINC free from arsenic and almost free from iron can be readily obtained from the commercial metal by exposing it simultaneously to the action of sulphur and watery vapour in such a manner that these agents rise from the bottom of the crucible through the melted metal.

Burnt gypsum is mixed with a fourth of its weight of coarsely powdered sulphur, and the mixture is made up to a paste with the necessary quantity of water. Of this, balls are moulded about 5 centimetres in diameter, and fixed, when dry, to the end of wooden rods of sufficient length and strength, so that they remain fast. When dry, the balls are ready for use. They are then pressed down into the melted metal to the bottom of the crucible. Abundant fumes of sulphur and water are given off and cause an agitation in the melted metal, so that caution is necessary. When the agitation ceases the ball is withdrawn, the scum is removed from the surface and the operation is repeated as required. One kilo. of zinc may be advantageously treated at once. The zinc thus purified is quite free from arsenic, and contains very slight traces of iron. The lead is also much diminished.—*Berichte Bœhm. Gesell. Wissen.*

SEPARATION OF NICKEL FROM COBALT.

REFERENCE is made to the methods of Terreil (*Comptes Rendus*, lxii., p. 139), and G. Delvaux (*Comptes Rendus*, xcii., p. 723). G. Vortmann modifies Delvaux's method by using, as oxidising agent, sodium hypochlorite in place of permanganate. If an ammoniacal solution of cobalt containing sal-ammoniac is mixed with sodium hypochlorite, complete oxidation ensues, even in the cold in a short time. The solution becomes of a deep red, and on adding excess of water, no basic salt of cobalt is deposited. If the liquid is boiled, the oxidation is more rapid; in a few minutes the solution takes a deep reddish-yellow colour and contains the cobalt chiefly as a luteo-salt. On diluting with water and adding potassa-lye the liquid remains clear, even on standing for days, if merely cobalt is present. If it also contains nickel, there is formed in a few minutes a precipitate of nickelous hydroxide. In this manner even traces of nickel may be detected in cobalt salts, and inversely small quantities of cobalt may be recognised in presence of nickel. The ammoniacal solution of nickel salts in presence of very small traces of cobalt shows, after treatment with sodium hypochlorite, a distinct reddish-violet colour. If this cannot be recognised, the precipitate formed by potash-lye after dilution with water is filtered off, and the faint yellow colour is observed in the filtrate. If only extremely minute traces of cobalt are present the filtrate may be colourless, but if heated with a little ammonium sulphide it gives a black precipitate of cobalt sulphide.

It must be remembered that nickelous hydroxide is slightly soluble in ammonia even in presence of potash- or soda-lye. Therefore an excess of ammonia at the beginning of the process is to be avoided.—*Zeitschrift Anal. Chemie.*

THE DETERMINATION OF ORGANIC MATTER IN WATER, ACCORDING TO THE METHODS DEPENDING ON THE REDUCTION OF PERMANGANATE.

By Dr. A. R. LEEDS.

THE author raises the objection that the oxidation of organic matter at common temperatures is less energetic than at 100°; that the execution of the process is tedious, and that the distinction of the organic matter present into putrescent and non-putrescent, according to the time that they are exposed to the action of the permanganate is based on an arbitrary assumption which cannot be correct. It hss been proposed to prolong the time of action to 24 hours, but even after so prolonged reaction the decomposition of the organic matter is not complete, and no additional insight is obtained into its nature. Hence for the last five years the determination of the organic matter in water has been performed in the author's laboratory at a boiling-heat, and according to the Kübel-Tiemann method. He has recently subjected this method to a very careful re-examination.

It was first ascertained what was the influence of a prolongation of the time of boiling. One hundred c.c. of water were boiled with 10 c.c. sulphuric acid (1 : 3), and the same volume of permanganate for 5, 10, 15, and 20 minutes. In one case the action became constant at 15 minutes; but in all the others there was a continued increase. The same water was then tried by the Schulz-Trommsdorff method, using instead of sulphuric acid 1 c.c. of a 20 per cent soda-lye. Here also the action was progressive and the oxidation was less energetic than with sulphuric acid. Ordinary distilled water was then examined by both methods, and here also progressive decomposition took place. Special distilled water, free from ammonia, was next tried with corresponding results. Hence it appears that from 0·30 to 0·35 c.c. permanganate

of the strength employed are necessary, to give 100 c.c. of the purest distilled water the rose tint which serves as final indication. Hence Dr. Leeds concludes:—

1. The Kübel-Tiemann's process must be retained. The determinations must be performed exactly in the same manner, and the duration of the experiment must be exactly five minutes.

2. The results must be connected by deducting the quantity of permanganate consumed in a blank experiment with *pure* distilled water.—*Zeitschrift für Analytische Chemie.*

CONTRIBUTIONS TO AZOTOMETRY.

By CARL MOHR.

AMONG the many methods proposed for determining nitrogen in nitrates and manurial mixtures none has met with so much approval as the reduction process with ferrous chloride, and measurement of the nitric oxide gas, as recommended by Schlösing, Grandeau, and others. Schlösing collects the gas over mercury, and Grandeau over water. To prevent the liquid from re-ascending into the decomposition-flask Muntz passes a current of carbonic acid through the apparatus and absorbs it by the introduction of a small volume of strong soda-lye. This ingenious proposal greatly facilitates the operation, since the nitric oxide gas is evolved only very slowly from the ferrous solution, a prolonged gentle boiling of the liquid being required. Here the carbonic acid renders essential service and enables with ordinary care the operation to be completed without accident. This method has, however, one defect: the inside of the gas burette moistened with soda-lye becomes very soon encrusted with crystals of sodium carbonate, rendering it difficult or impossible to read off the volume of gas. The author, therefore, employs instead of mercury or water a soda-lye of specific gravity 1·2 to 1·25. A lye of this strength absorbs the carbonic acid completely, and does not deposit crystals of sodium carbonate upon the glass. The current of carbonic acid passing through the apparatus disappears more and more towards the end of the process by absorption until finally the volume of gas remains constant.

The manipulation of a gas burette with caustic soda is rather difficult. The author has therefore designed a burette with a glass tap and a small cylindrical funnel. The burette is filled by aspirating from above by means of a caoutchouc tube and the tap is then closed.

The author has also designed an azotometer for ammoniacal salts and their mixtures. If the salt to be examined is approximately pure a 2 per cent solution is prepared. Of manurial mixtures 5 or 10 grms. are taken to 100 c.c. A graduated pipette, holding 10 c.c. and fitted with a small glass tap and an efflux point, is filled with this solution. A decomposition flask holding 150 c.c. is charged with 50 c.c. of a solution of bromine in caustic soda; the flask is then closed with a caoutchouc stopper having two perforations, through one of which is inserted the above-mentioned pipette, whilst a gas-tube serving as outlet passes through the other. The latter is connected by means of a short caoutchouc tube with the gas-burette above described. The introduction of the caoutchouc tube is necessary, as, after the decomposition, the flask must be shaken in order to liberate the absorbed nitrogen. After fitting up the gas-burette and introducing the pipette the tap is opened cautiously and 10 c.c. are allowed to flow in drop by drop. The evolution of gas takes place quietly and without perceptible heat. After the 10 c.c. have thus run in the apparatus is well shaken.—*Zeitschrift Anal. Chemie.*

The Electric Light in France.—The sluices of the Scarpe at Douai, a stream which connects all the canals of the North to the Scheldt, are lighted up by electricity, so that the barges are no longer delayed at night.—*Cosmos les Mondes.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

NICKEL AND COBALT.

ON account of the close similarity of these metals to each other, their atomic weights, approximately if not actually identical, have received of late years much attention.

The first determinations, and the only ones up to 1852, were made by Rothhoff;† each with but a single experiment. For nickel 188 parts of the monoxide were dissolved in hydrochloric acid; the solution was evaporated to dryness, the residue was dissolved in water, and precipitated by silver nitrate. 718·2 parts of silver chloride were thus formed; whence Ni=58·925. The same process was applied also to cobalt, 269·2 parts of the oxide being found equivalent to 1029·9 of AgCl. Hence Co=58·817. These values are so nearly equal that their differences were naturally ascribable to experimental errors. They are, however, entitled to no special weight at present, since it cannot be certain from any evidence recorded that the oxide of either metal was absolutely free from traces of the other.

In 1852 Erdmann and Marchand‡ published some results, but without details, concerning the atomic weight of nickel. They reduced the oxide by heating in a current of hydrogen, and obtained values ranging from 58·2 to 58·6, when O=16. Their results were not very concordant, and the lowest was probably the best.

In 1856, incidentally to other work, Deville|| found that 100 parts of pure metallic nickel yielded 262 of sulphate; whence Ni=59·15.

To none of the foregoing estimations can any importance now be attached. The modern discussion of the atomic weights under consideration began with the researches of Schneider§ in 1857. This chemist examined the oxalates of both metals, determining carbon by the combustion of the salts with copper oxide in a stream of dry air. The carbon dioxide thus formed was collected as usual in a potash bulb, which, in weighing, was counterpoised by a similar bulb, so as to eliminate errors due to the hygroscopic character of the glass. The metal in each oxalate was estimated, first by ignition in a stream of dry air, followed by intense heating in hydrogen. Pure nickel or cobalt was left behind in good condition for weighing. Four analyses of each oxalate were made, with the results given below. The nickel salt contained three molecules of water, and the cobalt salt two molecules:—

$NiC_2O_4.3H_2O$.

1·1945 grms. gave	0·528 grms. CO_2.	44·203 per cent.
2·5555 ,,	1·12625 ,,	44·072 ,,
3·199 ,,	1·408 ,,	44·014 ,,
5·020 ,,	2·214 ,,	44·104 ,,
	Mean	44·098 ± 0·027

The following percentages of nickel were found in this salt:—

29·107
29·082
29·066
29·082

Mean 29·084 ± 0·006

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† Cited by Berzelius. *Poggend. Annal.*, 8, 184. 1826.
‡ *Journ. f. Prakt. Chem.*, 55, 202. 1852.
|| *Ann. Chim. Phys.*, (3), 46, 182. 1856.
§ *Poggend. Annal.*, 101, 387. 1857.

$CoC_2O_4.2H_2O$.

1·6355 grms. gave	0·781 grms. CO_2.	47·753 per cent
1·107 ,,	0·5295 ,,	47·832 ,,
2·309 ,,	1·101 ,,	47·683 ,,
3·007 ,,	1·435 ,,	47·722 ,,

Mean 47·7475 ± 0·0213

The following were the percentages found for cobalt:—

32·552
32·619
32·528
32·523

Mean 32·5555 ± 0·0149

In a later paper* Schneider also gives some results obtained with a nickel oxalate containing but two molecules of water. This gave him 47·605 per cent of CO_2, and the following percentages of nickel:—

31·4115
31·4038

Mean 31·4076 ± 0·0026

The conclusion at which Schneider arrived was, that the atomic weights of cobalt and nickel are not identical, being about 60 and 58 respectively. The percentages given above will be discussed at the end of this chapter in connection with all the other data relative to the constants in question.

The next chemist to take up the discussion of these atomic weights was Marignac, in 1857.† His original paper is not accessible to me, and I am therefore obliged to give only such features of it as I can get from abstracts and reviews. He worked with the chlorides and sulphates of nickel and cobalt, using apparently common gravimetric methods. The sulphates, taken as anhydrous, were first ignited to expel SO_2+O, after which the residues were heated with weighed amounts of lead silicate. The increase in weight was CO_2 or NiO respectively. The anhydrous chlorides were prepared from the hydrated salts by ignition in dry chlorine or hydrochloric acid. With cobalt, the monohydrated chloride, dried at 100°, was also employed. For nickel he gives the following values, referred probably to O=16, S=32, Ag=108, Cl=35·5:—

From $NiSO_4$ .. .. .. Ni=58·4 to 59·0
,, $NiCl_2$ .. .. .. ,, 58·4 ,, 59·28

To cobalt these values are assigned:—

From $CoSO_4$ .. .. .. Co=58·64 to 58·76
,, $CoCl_2.H_2O$ .. .. ,, 58·84 ,, 59·02
,, $CoCl_2$.. .. .. .. ,, 58·72 ,, 59·02

That is, contrary to Schneider's view, the two atomic weights are approximately the same. The values for nickel, however, run a little lower than those for cobalt; a fact which is probably not without significance. Marignac criticises Schneider's earlier paper, holding that the nickel oxalate may have contained some free oxalic acid, and that the cobalt salt was possibly contaminated with carbonate or with basic compounds. In his later papers Schneider rejects these suggestions as unfounded, and in turn criticises Marignac. The purity of anhydrous $NiSO_4$ is not easy to guarantee, and, according to Schneider, the anhydrous chlorides of cobalt and nickel are liable to be contaminated with oxides. This is the case even when the chlorides are heated in chlorine, unless the gas is carefully freed from all traces of air and moisture.

Dumas's‡ determinations of the two atomic weights were made with the chlorides of nickel and cobalt. The pure metals were dissolved in aqua regia, the solutions were repeatedly evaporated to dryness, and the residual chlorides were ignited in dry hydrochloric acid gas. The last two estimations in the nickel series were made upon $NiCl_2$ formed by heating the spongy metal in pure chlorine. In the third column I give the $NiCl_2$ or $CoCl_2$, equivalent to 100 parts of silver:—

0·9123 grms. $NiCl_2$	=1·515 grms. Ag.	60·218
2·295 ,,	3·8115 ,,	60·212
3·290 ,,	5·464 ,,	60·212
1·830 ,,	3·041 ,,	60·178
3·001 ,,	4·987 ,,	60·176

Mean 60·1992 ± 0·0062

2·352 grms. $CoCl_2$	=3·9035 grms. Ag.	60·254
4·210 ,,	6·990 ,,	60·229
3·592 ,,	5·960 ,,	60·268
2·492 ,,	4·1405 ,,	60·186
4·2295 ,,	7·0255 ,,	60·202

Mean 60·2278 ± 0·011

These results give values for Co and Ni differing by less than a tenth of a unit; here, as elsewhere, the figure for Ni being a trifle the lower.

In 1863* the idea that nickel and cobalt have equal atomic weights was strengthened by the researches of Russell. He found that the black oxide of cobalt, by intense heating in an atmosphere of carbon dioxide, became converted into a brown monoxide of constant composition. The ordinary oxide of nickel, on the other hand, was shown to be convertible into a definite monoxide by simple heating over the blast lamp. The pure oxides of the two metals, thus obtained, were reduced by ignition in hydrogen, and their exact composition thus ascertained. Several samples of each oxide were taken, yielding the following percentages of metal.

NiO.

78·597 }
78·584 } 1st sample.
78·608 }

78·581 }
78·589 } 2nd sample.
78·583 }

78·616 }
78·590 } 3rd sample.
78·588 }

78·590 }
78·594 }
78·597 } 4th sample.
78·588 }

Mean of all 78·593 ± 0·0018

CoO.

78·591 }
78·588 }
78·550 } 1st sample.
78·598 }
78·614 }

78·603 }
78·591 } 2nd sample.
78·591 }

78·588 }
78·592 } 3rd sample.

78·597 }
78·598 } 4th sample.

78·595 }
78·589 } 5th sample.
78·596 }

Mean of all 78·592 ± 0·0023

These percentages are practically identical, and lead to essentially the same mean value for each atomic weight.

In a later paper Russell† confirmed the foregoing results by a different process. He dissolved metallic nickel and

* *Poggend. Annal.*, 107, 616.
† *Jahresbericht*, 1857, 225. *Bibl. Univ. de Genève*, (nouv. s.,) 1, 373.
‡ *Ann. Chem. Pharm.*, 113, 25. 1860.

* *Journ. Chem. Soc.*, (2), 1, 51.
† *Ibid.*, (2), 7, 494. 1869.

cobalt in hydrochloric acid and measured the hydrogen evolved. Thus the ratio between the metal and the ultimate standard was fixed without the intervention of any other element. About two-tenths of a grm. of metal, or less, was taken in each experiment. 100 parts by weight of Co or Ni give the following weights of H, calculated from the volume of the latter:—

Ni.		*Co.*	
3·420	1st sample.	3·395	1st sample.
3·418		3·398	
3·416		3·397	
3·417		3·398	
3·412		3·403	2nd sample.
3·415		3·401	
3·416		3·401	
3·398	2nd sample.	3·404	3rd sample.
3·409		3·405	
3·404		3·410	4th sample.
3·401	—3rd sample	3·407	
3·412	4th sample.		
3·408		3·4017	
3·410		Mean of all	
Mean of all 3·411 ± 0·001		± 0·0009	

A glance at the tabulated discussion which closes this chapter will show that these figures agree well with each other, and well with those found from the analyses of the oxides. The probable errors assigned in the hydrogen series may be a little too low, since they ought to be modified by the probable error of the weight of a unit volume of hydrogen. So insignificant a correction may, however, be neglected.

Some time after the publication of Russull's first paper, but before the appearence of his second, some other investigations were made known. Of these the first was by Sommaruga,* whose results, obtained by novel methods, closely confirmed those of Schneider and antagonised those of Dumas, Marignac, and Russell. The atomic weight of nickel Sommaruga deduced from analyses of the nickel potassium sulphate, $K_2Ni(SO_4)_2.6H_2O$, which, dried at 100°, has a perfectly definite composition. In this salt the sulphuric acid was determined in the usual way as barium sulphate, a process to which there are obvious objections. In the third column are given the quantities of the nickel salt proportional to 100 parts of $BaSO_4$:—

0·9798 grms. gave	1·0462 grms. $BaSO_4$.	93·653
1·0537 ,,	1·1251 ,,	93·654
1·0802 ,,	1·1535 ,,	93·645
1·1865 ,,	1·2669 ,,	93·654
3·2100 ,,	3·4277 ,,	93·649
3·2124 ,,	3·4303 ,,	93·648
	Mean	93·6505 ± 0·001

For cobalt Sommaruga used the purpureo-cobalt chloride of Gibbs and Genth. This salt, dried at 110°, is anhydrous and stable. Heated hotter, $CoCl_2$ remains. The latter, ignited in hydrogen, yields metallic cobalt. In every experiment the preliminary heating must be carried on cautiously until ammoniacal fumes no longer appear:—

0·6656 grms. gave	0·1588 grm. Co.	23·858 per cent.
1·0918 ,,	0·2600 ,,	23·814 ,,
0·9058 ,,	0·2160 ,,	23·846 ,,
1·5895 ,,	0·3785 ,,	23·813 ,,
2·9167 ,,	0 6957 ,,	23·847 ,,
1·8390 ,,	0·4378 ,,	23·806 ,,
2·5010 ,,	0·5968 ,,	23·808 ,,
	Mean	23·827 ± 0·006

Further along this series will be combined with a similar one by Lee. It may here be said that Sommaruga's paper was quickly followed by a critical essay from Schneider,* endorsing the former's work, and objecting to the results of Russell.

In 1867 still another new process for the estimation of these atomic weights was put forward by Winkler,† who determined the amount of gold which pure metallic nickel and cobalt could precipitate from a neutral solution of sodio-auric chloride. Experimentally, the method seems to be quite accurate; practically, it involves a knowledge of the defectively ascertained atomic weight of gold. In order to obtain pure cobalt Winkler prepared purpureo-cobalt chloride, which, having been four or five times recrystallised, was ignited in hydrogen. His nickel was repeatedly purified by precipitation with sodium hypochlorite. From material thus obtained pure nickel chloride was prepared, which, after sublimation in dry chlorine, was also reduced by hydrogen. 100 parts of gold are precipitated by the quantities of nickel and cobalt given in the third columns respectively. In the cobalt series I include one experiment by Weselsky, which was published by him in a paper presently to be cited:—

0·4360 grm. nickel precipitated	0·9648 gold	45·191
0·4367 ,,	0·9666 ,,	45·179
0·5189 ,,	1·1457 ,,	45·291
0·6002 ,,	1·3286 ,,	45·175
	Mean	45·209 ± 0·019

0·5890 grm. cobalt pptd.	1·3045 gold	45·151
0·3147 ,,	0·6981 ,,	45·080
0·5829 ,,	1·2913 ,,	45·141
0·5111 ,,	1·1312 ,,	45·182
0·5821 ,,	1·2848 ,,	45·307
0·559 ,,	1·241 ,,	45·044—Weselsky.
	Mean	45·151 ± 0·025

Weselsky's paper,‡ already cited, relates only to cobalt. He ignited the cobalticyanides of ammonium and of phenyl-ammonium in hydrogen, and from the determinations of cobalt thus made deduced its atomic weight. His results are as follows:—

0·7575 grm. $(NH_4)_6Co_2Cy_{12}$ gave	0·166 Co	21·914 per cent
0·5143 ,,	0·113 ,,	21·972 ,,
	Mean	21·943 ± 0·029

0·8529 grm. $(C_6H_8N)_6Co_2Cy_{12}$ gave	0·1010 Co	11·842 p.c.
0·6112 ,,	0·0723 ,,	11·829 ,,
0·7140 ,,	0·0850 ,,	11·905 ,,
0·9420 ,,	0·1120 ,,	11·890 ,,
	Mean	11·8665 ± 0·0124

Finally, we come to the work done by Lee§ in the laboratory of Wolcott Gibbs. Like Weselsky, Lee ignited certain cobalticyanides and nickelocyanides in hydrogen and determined the residual metal. The double cyanides chosen were those of strychnia and brucia; salts of very high molecular weight, in which the percentages of metal are relatively low. A series of experiments with purpureo-cobalt chloride was also carried out. In order to avoid admixture of carbon in the metallic residues, the salts were first ignited in air, and then in oxygen. Reduction by hydrogen followed. The salts were in each case covered by a porous septum of earthenware, through which the hydrogen diffused, and which served to prevent the mechanical carrying away of solid particles; furthermore, heat was applied from above. The results attained were very satisfactory, and assign to nickel and cobalt atomic weights varying from each other by about a unit; Ni being nearly 58, and Co about 59. The exact figures will appear later. The cobalt results agree remarkably

* *Sitzungsb. Wein. Akad.*, 54, 2, Abth., 50. 1866.

* *Poggend. Annal.*, 130, 310.
† *Zeit. Anal. Chem.*, 6, 18. 1867.
‡ *Ber. d. Deutsch. Chem. Gesell.*, 2, 592. 1868.
‖ *Am. Journ. Sci.*, (3), 2, 44. 1871.

well with those of Weselsky. The following are the percentages of metal found :—

In Brucia Nickelo-cyanide,
$Ni_3Cy_{12}(C_{23}H_{26}N_2O_4)_6H_6.10H_2O$.

5·724
5·729
5·750
5·733
5·712
5·729

Mean .. 5·7295 ± 0·0034

In Strychnia Nickelo-cyanide,
$Ni_3Cy_{12}(C_{21}H_{22}N_2O_2)_6\text{-}8H_2O$.

6·607
6·613
6·589
6·607
6·561
6·595

Mean .. 6·595 ± 0·005

In Brucia Cobalti-cyanide,
$Co_2Cy_{12}(C_{23}H_{26}N_2O_4)_6.H_6.20H_2O$.

3·759
3·720
3·739
3·748
3·747
3·749

Mean .. 3·7437 ± 0·0036

In Strychnia Cobalti-cyanide,
$Co_2Cy_{12}(C_{21}H_{22}N_2O_2)_6.H_6.8H_2O$.

4·583
4·596
4·554
4·564
4·577
4·549

Mean .. 4·5705 ± 0·005

In Purpureo-cobalt Chloride,
$Co_2(NH_3)_{10}Cl_6$.

23·575
23·587
23·586
23·579
23·569
23·581

Mean .. 23·5795 ± 0·0019

The last series may be combined with Sommaruga's, thus :—

Sommaruga	23·827	± 0·006
Lee	23·5795	0·0019
General mean ..	23·6045	0·0018

In discussing the atomic weights of nickel and cobalt we may ignore the work of Rothhoff, Erdmann and Marchand, and Deville. That of Marignac must also be omitted for want of sufficient data. For nickel we have the following ratios. The probable error assigned in No. 4 is that of a single experiment in No. 2 :—

(1) Per cent of Ni in $NiC_2O_4.3H_2O$, 29·084 ±0·006
(2) ,, CO_2 from ,, 44·098 ±0·027
(3) ,, Ni in $NiC_2O_4.2H_2O$ 31·4076±0·0026
(4) ,, CO_2 from ,, 47·605 ±0·053
(5) ,, Ni in NiO, 78·593 ± 0·0018
(6) ,, Ni in brucia nickelo-cyanide, 5·7295 ±0·0034
(7) ,, Ni in strychnia nickelo-cyanide, 6·595 ±0·005
(8) Ag : $NiCl_2$: : 100 : 60·1992 ± 0·0062
(9) Ni : H : : 100 : 3·411 ± 0·001
(10) Au : Ni : : 100 : 45·209 ± 0·019
(11) $BaSO_4 : K_2Ni(SO_4)_2.6H_2O$: : 100 : 93·6505±0·001

Since the proportion of water in the oxalates is not an absolutely certain quantity, the data concerning such salts are best handled by employing the ratios between the carbon dioxide and the metal. Accordingly ratios (1) and (2) give a single value for Ni, and ratios (3) and (4) another. In all we have nine values for the atomic weight in question :—

From (1) and (2) . ..	Ni =	57·907 ±	0·0379
,, (3) and (4) . ..	,,	57·926	0·0654
,, (6)	,,	57·884	0·0396
,, (7)	,,	57·947	0·0467
,, (11)	,,	58·170	0·0829
,, (5)	,,	58·607	0·0139
,, (9)	,,	58·634	0·0165
,, (8)	,,	58·899	0·0339
,, (10)	,,	59·120	0·0376
General mean ..	,,	58·547	0·0089

If O = 16 Ni = 58·682.

In the foregoing result it will be seen that the two sets of figures due to Russell receive very great weight. This is because the one set is referred directly to hydrogen, without the intervention of the probable error of any other element; while the second set involves only the atomic weight of oxygen, of which the probable error is small. As regards accuracy of methods, however, and certainty concerning the purity of material, Russell's work is no better than Schneider's, and probably inferior to Lee's. Now values one to five in the above table represent the tolerably concordant results of Schneider, Lee, and Sommaruga. They, combined by themselves, give a general mean of Ni = 57·928 ± 0·0215; or, if O = 16, of Ni = 58·062. This value, taking everything into account, I cannot but regard as more likely to prove correct than the larger mean deduced from all the ratios. At all events, the atomic weight of nickel needs further careful investigation.

For cobalt these ratios are available :—

(1) Per cent of Co in $CoC_2O_4.2H_2O$, 32·5555 ± 0·0149
(2) ,, CO_2 from ,, 47·7475 ± 0·0213
(3) ,, Co in CoO, 78·592 ± 0·0023
(4) ,, ,, purpureo-cobalt chloride, 23·6045 ± 0·0018
(5) ,, ,, phenylammonium cobalti-cyanide, 11·8665 ± 0·0124
(6) ,, ,, ammonium cobalti-cyanide, 21·943 ± 0·029
(7) ,, ,, brucia cobalti-cyanide, 3·7437 ± 0·0036
(8) ,, ,, strychnia cobalti-cyanide, 4·5705 ± 0·005
(9) Ag : $CoCl_2$: : 100 : 60·2278 ± 0·11
(10) Co : H : : 100 : 3·4017 ± 0·0009
(11) Au : Co : : 100 : 45·151 ± 0·025

Hence we have ten values for Co, as follows :—

From (1) and (2) . ..	Co =	59·865 ±	0·0394
,, (4)	,,	59·080	0·0152
,, (5)	,,	58·913	0·0628
,, (6)	,,	59·177	0·0816
,, (7)	,,	59·057	0·0581
,, (8)	,,	58·960	0·0708
,, (11)	,,	59·044	0·0436
,, (9)	,,	58·961	0·0392
,, (3)	,,	58·604	0·0145
,, (10)	,,	58·794	0·0162
General mean ..	,,	58·887	0·008

If O = 16, Co = 59·023.

The following additional note has been communicated by the author :—

Since this chapter was written the atomic weight of nickel has been re-determined by Baubigny.* Two calcinations of $NiSO_4$ gave a residue of NiO equal, in mean, to 48·280 per cent. Hence Ni=58·598; or, if SO_3=80, Ni=58·679.

ON THE

PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.†

By F. W. PAVY, M.D., F.R.S.

(Continued from page 142.)

Situation of the Converting Principle in the Ruminant Animal.

This deserves special consideration. In the course of my experiments I tried the stomach (true or fourth) and intestine of the sheep, and was astonished to find that no conversion took place. I was at a loss to understand that a vegetable feeder like the ruminant should thus be unprovided with the converting principle existing even in the alimentary tract of the carnivorous animal. This led me to experiment with the other portions of the ruminant stomach, and the results at once showed that the sheep is exceptional only in the position in which the converting principle is to be found. Whilst absent in the fourth or true stomach and the intestine, it is present in the paunch, reticulum, and the many-plies or third stomach. It is really interesting to note that this condition of things should exist and stand so strictly in accord with what seems reasonable to look for under the altered circumstances. Instead of what is swallowed passing in at once into the stomach and thence into the intestine as ordinarily occurs, the disposition in the ruminant is such that the food when first swallowed passes into the paunch and reticulum. Here it is delayed for some time and a favourable position afforded for the absorption of a diffusible substance like glucose. From these two stomachs the food is then regurgitated into the mouth, and, after thorough comminution, swallowed a second time and conveyed to the many-plies [or third stomach. By the arrangement existing in this cavity with its numerous laminæ or folds disposed like the leaves of a book, an extensive surface is passed over by the comminuted food before the fourth or true stomach is reached. Thus the paunch, reticulum, and many-plies are traversed by the food in such a manner that absorption of any glucose present is likely to occur before the true stomach is reached, and observation shows that the converting principle exists in the paunch, reticulum, and many-plies, and not in the true stomach and intestine as in non-ruminant animals.

Subjoined are results illustrative of what I have said :—

Experiment.—Portions of the four stomachs and the small intestine of a recently-killed sheep were taken for the experiment. Finely divided portions of each were placed in separate beakers, and about 50 cub. centims. of water added, and then 10 cub. centims. of a solution of grape sugar, containing 0·128 grm. glucose. The beakers were exposed side by side for two hours to a temperature of 120° F. (48·8° C.), and afterwards allowed to remain for eighteen hours at the ordinary temperature. The analyses were now conducted, and the following results obtained :—

Paunch.

Before sulphuric acid	0·074 grm.
After „ „	0·128 „

Second Stomach (reticulum).

Before sulphuric acid	0·082 grm.
After „ „	0·124 „

Third Stomach (many-plies).

Before sulphuric acid	0·110 grm.
After „ „	0·128 „

Fourth Stomach (reed or true stomach).

Before sulphuric acid	0·124 grm.
After „ „	0·130 „

Intestine.

Before sulphuric acid	0·124 grm.
After „ „	0·124 „

The Portal Blood after the Ingestion of Grape Sugar.

An examination of the portal blood after the introduction of glucose into the stomach of a fasting animal may be considered as furnishing evidence of what has actually taken place during life. The experiments I have previously referred to have shown that glucose is moved into a body of lower cupric oxide reducing power by the agency of certain parts of the alimentary tract. The power to produce the change has been shown to belong to certain parts of the alimentary tract, but something more is wanted to prove that such change actually occurs as a phenomenon of life. The mode or experimenting now under consideration supplies this proof. A solution of glucose is introduced into the stomach of a fasting animal, and the animal afterwards killed, and the portal blood which contains the products of absorption from the alimentary canal collected and examined. If glucose were absorbed unchanged glucose should be encountered in the portal blood, but observation, as will be seen by the experimental results adduced below, shows that instead of glucose a product of lower cupric oxide reducing power than maltose is present. Thus everything conspires to indicate that upon entering the system glucose is moved into a body of lower cupric oxide reducing power. Such must be spoken of as constituting the first step towards the assimilation or appropriation of this principle within the system. Subjoined are the details of four experiments, two upon the herbivorous and two upon the carnivorous animal.

Experiment.—One ounce (28 grms.) of grape sugar dissolved in three ounces (85 cub. centims.) of water was injected through a flexible tube passed down the œsophagus into the stomach of a rabbit which had not been fed for twenty-eight hours. One hour and a quarter afterwards the rabbit was killed, and the abdomen immediately opened, and the blood collected from portal vein. The blood was prepared for examination into the usual way by pouring it into spirit, and dealing with the alcoholic extract by evaporating off the spirit and treating the residue with sulphate of soda. The following are the results that were obtained expressed as parts per 1000 :—

Portal Blood.

Before sulphuric acid	2·222 per 1000.
After „ „	5·444 „

Relation 40 to 100.

Experiment.—Half-an-ounce (14 grms.) of grape sugar dissolved in three ounces (85 cub. centims.) of water were injected into the stomach of a rabbit which had not been fed for twenty-four hours. The rabbit was killed at the end of half-an-hour, and the portal blood collected and analysed.

Portal Blood.

Before sulphuric acid	1·700 per 1000
After „ „	3·400 „

Relation 50 to 100.

Experiment.—500 grains (32 grms.) of grape sugar dissolved in one and a-half ounces (43 cub. centims.) of water were injected into the stomach of a dog which had not been fed for twenty-four hours. In twenty-five minutes time the dog was killed, the abdomen immediately opened, and the portal blood collected and analysed. Duplicate analyses for the sake of check were made, and the following are the figures that were yielded :—

* *Compt. Rend.*, 97, 951.
† A Paper read before the Royal Society, Dec. 20th, 1883.

Portal Blood.

I. Before sulphuric acid	.. .. ..	1·200 per 1000.
After " "	.. .. ..	2·233 "
Relation 53·7 to 100.		
II. Before sulphuric acid	.. .. ..	1·200 per 1000.
After " "	.. .. ..	2·200 "
Relation 54·5 to 100.		

Experiment.—500 grains (32 grms.) of grape sugar dissolved in one ounce (28 cub. centims.) of water were injected into the stomach of a dog which had not been fed for twenty-four hours. The dog was killed at the end of twenty minutes, the abdomen immediately opened and the portal blood collected. The blood from the right ventricle was also collected, and both submitted to analysis. The right ventricular blood will be seen to have contained glucose, and in about the usual amount, viz., 0·5 per 1000.

Portal Blood.

Before sulphuric acid	.. .. ..	0·866 per 1000.
After " "	.. .. ..	1·666 "
Relation 51 to 100.		

Right Ventricle Blood.

Before sulphuric acid	.. .. ..	0·466 per 1000.
After " "	.. .. ..	0·466 "

Extent of the Conversion of Glucose.

Reference to the preceding results will show that in the change which glucose undergoes it is moved not only as far as maltose, but into the position of considerably lower cupric oxide reducing dextrins. When a reducing power above 61 against 100 for glucose is presented, it may be that we have a mixture of maltose and glucose to deal with, although I have nothing absolutely before me to enable me to state that such is the case, for it may be possible that there are products with reducing power standing between maltose and glucose, just as there are products—the dextrins—with reducing powers below that of maltose.

The lowest point to which in my observations upon the alimentary tract I have yet noticed glucose to have been moved, is into a product with a cupric oxide reducing power of 40 as compared with glucose at 100.

In an experiment just performed a moderately strong solution of glucose was exposed in contact with a considerable quantity of the previously dried stomach of the rabbit to a temperature of 120° F. (48·8° C.). 50 cub. centims. of the liquid were removed for analysis at the end of one hour, and another 50 cub. centims. at the end of two hours; the two portions yielded on analysis identically the same figures, showing that the point attained represents the full amount of working power derivable from the active principle present, and that after an hour no further action was exerted. The figures stood as follows:—

Before sulphuric acid	.. .. ..	0·082 grm.
After " "	.. .. ..	0·188 "
Relation 43 to 100.		

As I have stated, the dried stomach was here employed. The stomach may be inflated and dried and thus preserved for use. It is, necessary, however, that self-digestion should not have been allowed to advance after death. Unlike the active principle of digestion—pepsin—which does not undergo self-digestion, the active principle concerned in the transformation of glucose is susceptible of being destroyed by the agency of gastric digestion. At least so it appears from the results that have presented themselves to me.

Cane Sugar.

Cane sugar is characterised by possessing no cupric oxide reducing power and by becoming converted into glucose by boiling with sulphuric acid.

In all experiments with cane sugar it is necessary to see that the specimen employed gives no cupric oxide reducing action. Specimens often contain more or less of a cupric oxide reducing body as an impurity.

For the conversion of cane sugar and the products of the action of ferments upon it into glucose by boiling with sulphuric acid, a great difference in the length of time required exists from that required for all the other carbohydrates. A 2 per cent strength of acid is used as for the other carbohydrates, and appeal to observation has satisfied me that full conversion may be considered to have taken place after boiling for five minutes. In reality, under examination by quantitative determination a different length of time, I have noticed full conversion to have taken place before the expiration of three minutes. For the sake of absolute security, however, I allow in my experiments seven minutes. To this extent the boiling may be carried, but boiling for a longer time is liable to lead to the development of colour, which interferes with the subsequent titration with the ammoniated cupric test, and is therefore to be avoided. The colour may not have shown itself to any decided extent in the product on the completion of the boiling, but becomes apparent during the process of neutralisation preparatory to titration. This remark about the development of colour not only applies to cane sugar but to the products derived from it by the action of ferments.

In consequence of the development of colour, the use of the high-pressure boiler, which may be employed for the conversion into glucose of starch, starch dextrins, and starch maltose, and also the products derived from the transformation by fervent action of glucose, is inadmissible in experiments with cane sugar. As will be subsequently seen, lactin stands in the same position as cane sugar in requiring precautions to be taken to prevent the development of colour in the process of conversion into glucose by the action of sulphuric acid.

The Salivary and Pancreatic Ferments and Cane Sugar.

Under this head I have simply to state that in order to deal with the matter systematically, and not to take anything for granted, I have submitted cane sugar to the influence of contact, under suitable conditions, with the saliva and the pancreas of the cat, dog, and sheep, and have not found that evidence has been furnished of any change being induced.

(To be continued.)

NOTICES OF BOOKS.

Handbook of Patent Laws. By W. P. Thompson, C.E. Sixth Edition, revised. London: Stevens and Sons.

A new edition of this manual must be pronounced timely, in view of the recent changes both in patent law and patent procedure. As a matter of course we cannot notice this book without to some extent criticising the principal features of the new Act, which leaves very much to be desired.

The author's preface contains, in common with the recent Act, an unfortunate reference to the Statute of Monopolies. We say unfortunate because the very word "monopolies" throws the typical free-trader into such a state of excitement that he cannot be reasoned with. We believe the mere use of this word, in connection with patent-right and copy-right, explains many of the attacks which have been latterly directed against both. Mr. Thompson writes:—"In the reign of James I. the Statute of Monopolies abolished and made illegal for the future these exclusive privileges, with a single reservation in favour of patents for invention, granted to the inventor for a limited period 'for any new manufacture *within the realm*.'" Now it seems to us that the author would have done well to point out the radical difference between a monopoly and a patent for an invention. One of the highest legal authorities known, Sir E. Coke, defines a

monopoly as an exclusive privilege granted to some person or corporation to do something which was formerly free and open to all men. But the exclusive right of the patentee is, on the contrary, to do something which, prior to the invention, was out of the reach of all men. Hence the patentee, unlike the monopolist, does not deprive the public of any right which they had heretofore enjoyed. This consideration, surely, ought to appease the free-trader, unless he claims the right of trading freely with his neighbours' property. It may be interesting here to note that whilst in Britain patent-right and copy-right are denounced by free-traders as "relics of protectionism," international copy-right is opposed by American protectionists as a free-trade movement!

We must here call special attention to those words in the quotation from the "Statute of Monopolies" which we have italicised, "within the realm." These words, without going any further, seem to show that the fundamental idea of a patent, whether invented or imported, was its being worked, if at all, within the realm. Yet there are many scores of British patents, often of a very valuable character, held by aliens domiciled abroad who never had the least intention of working such patents on British ground, and have obtained them merely to prevent any other person from so working. Thus our patent-laws, originally designed to foster the introduction of new arts into the realm, are ingeniously made the means of keeping them out! By what process our courts have persuaded themselves that this perversion is in harmony with the dictates of common sense we are of course unable to divine. But it may be interesting to note that we are the only nation of industrial importance which allows its patent-law to be turned to such a use. This in Austria-Hungary, as may be seen in the manual before us, an invention must be practised in the empire within a year from date of patent. In Belgium a patent is annulled if it is worked abroad with the knowledge of the inventor, but not in Belgium. Brazil requires *bona fide* working within three years of grant to such an extent as "to supply the wants of the country at reasonable rates." In France the invention must be worked within two years. In Germany a three years limit is fixed, after which the patent is forfeited.

It is to be regretted that the Patent Act of last year does not contain some very distinct provision of a similar nature, since it is evident that this country has been a very serious loser by the exisiting practice. There is, indeed, a stipulation that the patentee is bound to grant licenses on "reasonable" terms if it appear that the patent is not being worked in the United Kingdom, but the penalty of refusal is even in this case not forfeiture.

A feature in the German patent law, which we might very advantageously have borrowed, is that foods, drinks, and medicines are not patentable. This provision would strike a death-blow at quackery and at certain forms of sophistication.

Another strange and indefensible peculiarity of the British patent law is that its action is confined to England, Scotland, Ireland, and the Channel Islands. Under the so-called "old law" prior to 1852, a patent obtained in England, though it did not cover Ireland and Scotland, yet could be extended to "all Her Majesty's dominions and plantations abroad." We have never seen or heard of any reason for the discontinuance of this extension. A mere stroke of the pen would last year have made the Act apply to India and the Crown Colonies, conferring an equal benefit upon English and colonial inventors. And we doubt not that the legislatures of Canada, Australia, and other such colonies would hail as a boon an Imperial patent law. It must be remembered that a Spanish patent covers Cuba, the Phillipines, the Canaries, &c., and that a French patent holds good in Algeria. To these short-comings in the new Act Mr. Thompson does not refer so far as we can perceive. His work, however, is a very clear and fair guide to the patent laws of most countries, and will prove of great use to patentees.

CORRESPONDENCE.

POTASSIUM TELLUROCYANATE.

To the Editor of the Chemical News.

SIR,—About two months ago some notes of mine on the separation of tellurium and selenium were sent to you in the hope that they might find a place in the CHEMICAL NEWS,* and in them I have called attention to the evidence there is of the existence of *potassium tellurocyanate*. This evidence is that tellurium, when heated with solution of potassium cyanide, dissolves to a slight extent in such a form as to be—like seleno-cyanate—precipitable by hydrochloric acid, but non-precipitable by air or by a hot alkaline solution of glucose. This observation is not in accordance with what is to be found in "Watts's Dictionary," the "Select Methods of Chemical Analysis," and other works of authority. The *Zeitschrift*, vol. i., to which Fresenius refers in his "Quantitative Analysis," for an abstract of H. Rose's analytical work on this subject, also makes no mention of *tellurocyanate*.

Assuming that my notes will have appeared in the CHEMICAL NEWS before this reaches you, I write to say that Dr. Divers has just observed and pointed out to me in Rose's "Quantitative Analyse Tinkener," that its distinguished author had nevertheless observed the fact noted by me, of the reaction of tellurium with potassium cyanide and hydrochloric acid, and had given the same explanation of it as I have done. The application of the sugar-test as a verification is still my own, however, and besides I hope that my notice of the hydrochloric reaction and its significance may be of service in bringing Rose's work before the attention of chemists again, since it appears to have been quite lost sight of by subsequent writers on the subject.—I am, &c.,

MASACHIKA SHIMOSÉ.

Imperial Japanese College of Engineering, Tokio,
February 8th, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 5, February 4, 1884.

Transformation of Glyoxal into Glycolic Acid.—M. de Forcrand.—The author has obtained glyoxal by the action of nitric acid upon aldehyd. The glyoxal is then converted into glycolic acid by the action of an excess of water at 150°.

Antimony Fluoride.—M. Guntz.—The fact that antimony fluoride is not like the majority of antimony salts decomposed by an excess of water, and can be re-crystallised from its solutions, induced the author to make a thermo-chemical study of this compound. The absorption of heat on dissolving antimony fluoride in water increases with dilution and tends towards -2 cal.

Transformation-Heat of Prismatic Antimony Oxide into the Octahedral Oxide.—M. Guntz.—The conversion of the octahedral into the prismatic oxide is attended with the liberation of $+0{\cdot}6$ cal.

Case of Isomerism of Chloro-nitrised Camphor.—P. Cazeneuve.—The author described the normal chloro-nitrised compound in February, 1883, and at the same time obtained a body which he now proves to be an isomer. It is dextro-rotatory and very soluble in cold alcohol. The normal compound is lævo-rotatory, and dissolves very sparingly in cold alcohol.

* See CHEMICAL NEWS, vol. xlix., p. 26.

No. 6, February 11, 1884.

Note on Faraday's Law.—Ed. Wurtz.—The author argues that in the interpretation of Faraday's law it is not the notion of atomic weights which should intervene, but that of valence. The quantity of metals deposited at the negative pole in the electrolysis of polyvalent metals does not in any manner correspond with the equivalents ordinarily adopted.

Absolute Total Actinometer.—M. G. A. Hahn.—The author's apparatus consists substantially of a retort exposed to the sun, and connected with a condenser and receiver placed in the shade, but in the open air. Carbon disulphide is poured into the retort and a vacuum is made in the apparatus so that it may contain merely the vapour given off by the liquid. As long as the sky is overcast the liquid remains in the retort without distillation or condensation. As soon as the sun shines the carbon disulphide begins to boil and the liquid collected in the receiver in a unit of time is proportional to the quantity of solar heat received in the same time.

Summary of Strokes of Lightning recorded in France during the first Half Year of the Year 1883.—Communicated by the Postmaster General.—A series of tables which do not admit of abstraction.

The Law of Joule.—P. Garbe.—Whilst examining the relation between the nature of the radiations emitted by incandescent lamps, and the energy radiated by these lamps, the author has been led to a verification of Joule's law in the case of incandescent bodies. Whilst the electric work expended in a certain time was 430·94 cals., the heat received by the calorimeter in the same time was 430·71 cals.

Electric Conductibility of very Dilute Saline Solutions.—E. Bouty.—Referring to his former paper on the same subject (*Comptes Rendus*, xcviii., p. 140), the author has verified his conclusions at different temperatures, and finds that the conductibility of all the solutions studied is one and the same function of temperature. The relation of these conductibilities remains invariable when the temperature changes, and the law of equivalents established at 15° is found exact at every other temperature.

Liquefaction of Hydrogen.—K. Olszewski.—The author's latest experiments demonstrate that hydrogen when submitted to a pressure of 199 atmos. and cooled by oxygen boiling in vacuo (6 m.m. of mercury) does not show a meniscus, but, if suddenly released there appears a momentary ebullition, not lasting a second, and small colourless drops are projected into the upper part of the tube. This phenomenon is quite analogous to that observed by M. Cailletet in oxygen, cooled by ethylene (boiling under the atmospheric pressure), and submitted to a sudden release. The author concludes that the temperature of oxygen boiling in a vacuum is as insufficient for liquefying hydrogen, even under a considerable pressure, as is the temperature of ethylene boiling at atmospheric pressure for obtaining liquid oxygen in a static condition. It seems to him that the evaporation of liquid oxygen cannot give a temperature as low as that used in his experiments.

The Law of Thermic Substitution Constants.—D. Tommasi.—In opposition to M. Berthelot the author maintains that his law is applicable not only to the salts of lead and mercury, but also to all other soluble salts, as appears from a comparison of the calculated numbers with the experimental results.

Formation of Methyl Iodide and Methylene Iodide at the Expense of Iodoform.—P. Cazeneuve.—The most favourable conditions for the production of these compounds are as follows:—500 grms. of iron (reduced by hydrogen) are intimately mixed with an equal weight of finely powdered iodoform, and 200 grms. of water are then added. A gentle heat is applied, and 120 grms. are collected of a mixture comprising 40 grms. methyl iodide, and 80 grms. methylene iodide, which are easily separated by heating in a vacuum.

Monobromised Methyl-Chloroform.—L. Henry.—This compound is a colourless liquid, perfectly limpid, not affected by light, of a peculiar ethereal odour and a taste at once sweetish and pungent. Its density at 0° is 1·8839. It boils without decomposition under the ordinary pressure at 151° to 153°. Its vapour-density is 7·46, calculation giving 7·34. Under the action of caustic alkalies it loses 1 mol. of hydrochloric acid. It completes the β-series of chloruration of ethyl bromide.

Manufacture of Farm-Yard Manure.—P. P. Dehérain—The temperature in a dung-heap varies from 28° to 68° in different strata. The gases in the upper portion are carbonic acid and nitrogen; lower down the nitrogen diminishes, and the carbonic acid increases. At the bottom there are found merely carbonic acid and marsh-gas. The production of this latter gas is caused by an organised ferment, and ceases on the addition of chloroform. The rise of temperature is due to an oxidation of the organic matter by free oxygen.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bleach Processes.—Information is requested on two bleach processes—the one, Peter Thomas's patent permanganate and sulphuretted borax, and the other, Charles Tappan's paraffin soap process. Any information as to working, &c., will much oblige.—G. H. D.

MEETINGS FOR THE WEEK

Monday, April 7th.—Medical, 8.30.
—— Society of Chemical Industry, 8. Election of Local Committee. "Preliminary Note on certain By-products of the Pintsch Oil-Gas Manufacture, in relation to the question of the conditions under which Benzenes are formed," by Dr. Armstrong. "On the Estimation of Sulphurous Acid in its Compounds," by Messrs. Giles and Shearer. "Further Note on the Solidification of Liquid Oils," by Mr. W. J. Carpenter.
Tuesday, 8th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Photographic, 8.
Wednesday, 9th.—Microscopical, 8.

THE CHEMICAL NEWS.

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THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

Introduction.

1. IN March, 1881, I sent to the Royal Society a preliminary notice of some results I had obtained when working on the molecular discharge in high vacua.† When the spark from a good induction coil traverses a tube having a flat aluminium pole at each end, the appearance changes according to the degree of exhaustion. Supposing atmospheric air to be the gas under exhaustion, at a pressure of about 7 millims. a narrow black space is seen to separate the luminous glow and the aluminium pole connected with the negative pole of the induction coil. As the exhaustion proceeds this dark space increases in thickness, until, at a pressure of about 0·02 millim. (between 20 and 30 M.),‡ the dark spark has swollen out till it nearly fills the tube. The luminous cloud showing the presence of residual gas has almost disappeared, and the molecular discharge from the negative pole begins to excite phosphorescence on the glass where it strikes the side. There is great difference in the degree of exhaustion at which various substances begin to phosphoresce. Some refuse to glow until the exhaustion is so great that the vacuum is nearly non-conducting, whilst others begin to become luminous when the gauge is 5 or 10 millims. below the barometric level. The majority of bodies, however, do not phosphoresce till they are well within the negative dark space. This phosphorogenic phenomenon is at its maximum at about 1 M., and, unless otherwise stated, the experiments now about to be described were all tried at this high degree of exhaustion.

Under the influence of this discharge, which I have ventured to call radiant matter, a large number of substances emit phosphorescent light, some faintly and others with great intensity. On examining the emitted light in the spectroscope most bodies give a faint continuous spectrum, with a more or less decided concentration in one part of the spectrum, the superficial colour of the phosphorescing substance being governed by this preponderating emission in one or other part of the spectrum.

Sometimes, but more rarely, the spectrum of the phosphorescent light is discontinuous, and it is to bodies manifesting this phenomenon that my attention has been specially directed for some years past, considerable interest attaching to a solid body whose molecules vibrate in a few directions only, giving rise to spectrum lines or bands on a dark background.

The Citron Band Spectrum.

2. For a long time past I have been haunted by a bright citron-coloured band or line appearing in these phosphorescent spectra, sometimes as a sharp line, at others as a broader nebulous band, but having always a characteristic appearance and occurring uniformly in the same spot. This band I first saw in the summer of 1879, and from that date down to a comparatively short time ago all my efforts to clear up the mystery proved vain. By chemical means it was not difficult to effect a partial separation of a certain mineral or earthy body into two parts, one giving little or no citron band, the other giving one stronger than the original band; and by again treating this latter portion by appropriate chemical means, the citron band-forming body could frequently be still more concentrated; but further than this for a long time it seemed impossible to go. I soon came to the conclusion that the substance I was in search of was an earth, but on attempting to determine its chemical properties I was baffled. A more Proteus-like substance a chemist never had to deal with. In my preliminary note, above referred to, speaking of the possibility that some of these spectrum-forming bodies might be new chemical elements, I said—"The chemist must be on his guard against certain pitfalls which catch the unwary. I allude to the profound modification which the presence of fluorine, phosphorus, boron, &c., causes in the chemical reactions of many elements, and to the interfering action of a large quantity of one body on the chemical properties of another which may be present in small quantities."

3. This warning was not unnecessary. No Will-o'-the-Wisp ever led the unwary traveller into so many pitfalls and sloughs of despond as the hunt for this phantom band has entrapped me. I have started with a large quantity of substance which, from preliminary observations, promised to be a rich mine of the desired body, and have worked it up chemically to a certain point, when the citron band vanished, and could not be again detected in either precipitate or filtrate. Half a-dozen times in the last four years the research has been given up as hopeless, and only a feeling of humiliation at the thought of a chemist being beaten by any number of anomalies made me renew each time the attack. Likewise, the tedious character of the research made a long continuance of failures very disheartening. To perform a spectrum test, the body under examination must be put in a tube and exhausted to a very high point before the spectroscope can be brought to bear on it. Instead of a few minutes, many hours are occupied in each operation, and the tentative gropings in the dark, pre-eminently characteristic of this kind of research, have to be extended over a long period of time.

4. I soon found that the best way to bring out the band was to treat the substance under examination with strong sulphuric acid, drive off excess of acid by heat, and finally to raise the temperature to dull redness (10). The anhydrous sulphate thus left frequently showed the citron band in the radiant matter tube, when before this treatment the original substance showed nothing (75).

Examination of Calcium Compounds.

5. My first idea was that the band might be due to a compound of lime. Much chemical evidence tended to support this view. I have already explained that the chemical extraction was rendered very difficult by the fact of the citron band so frequently turning up both in the precipitate and the filtrate. By neglecting the portion showing least citron band, and separating all the elements present which gave little or none, I could generally concentrate the citron band into a solution which—according to our present knowledge of analytical chemistry—should contain little else than the earths, alkaline earths, and alkalies. Ammonia added to this solution would precipitate an earth (11, 14), and in the filtrate oxalic acid would precipitate an insoluble oxalate (7, 13).

The citron band hovered between these two precipitates, being sometimes stronger in one and sometimes in the other. It was also to be detected, but more faintly, in the residue left after evaporating to dryness and igniting the filtrate from the oxalate.

I frequently obtained no precipitate with ammonia, and then the oxalate gave the band brilliantly; and occasionally the ammonia precipitate when formed gave little or no citron band. I was, however, generally sure to find it in the insoluble oxalate, and sometimes it was very brilliant, being accompanied by two bright green bands and a fainter red band.

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.
† *Proceedings of the Royal Society*, No. 213, 1881.
‡ M = one-millionth of an atmosphere.

6. At this time one of the minerals which showed the citron band most strongly was a phosphorescent apatite from Ireland; and knowing the difficulties of separating the last traces of phosphoric acid from the earths, I explained the foregoing facts by the presence of small quantities of phosphoric acid, which gave rise to the ammonia precipitate; the bulk of the citron body not being precipitated by ammonia, but coming down as oxalate; whilst a little of this oxalate would remain dissolved in the ammoniacal salts present, and so appear with the alkalies.

I tested this hypothesis in every imaginable way, by mixing small quantities of phosphoric acid with salts of lime and other earths, in the endeavour to imitate the conditions occurring in the native minerals, and so educe the citron band; but I was unable to get any precipitate giving the citron band when I started with materials which did not originally give it.

7. A sufficient quantity of precipitated oxalate (5) having in course of time been accumulated, I attempted its purification. It was ignited, dissolved in dilute hydrochloric acid, and rendered slightly alkaline with ammonia and ammonic sulphide. The liquid was boiled to a small bulk, keeping it alkaline, and was then set aside in a warm place: a slight flocculent precipitate formed. This was filtered, and the filtrate re-concentrated. The clear strong solution should now contain nothing but barium, strontium, and calcium, with traces of elements from previous groups which might be soluble in the precipitants employed or in the ammoniacal salts present (for we know that the word *insoluble* applied to a precipitate is not an absolute term, and in minute analysis allowance must be made not only for the slight solubility of precipitates in the reagents present, but also for the power possessed by most precipitates of carrying down with them traces of soluble metallic salts from solution). Besides these, it was possible that a hitherto unrecognised element might be present, to which the citron band was due. By the ordinary process of analysis I could, however, only detect the presence of calcium and strontium.

8. The concentrated ammoniacal solution was added to an excess of a boiling solution of ammonic sulphate, and the whole was set aside for twenty-four hours; the precipitate which had formed was filtered off and washed with a saturated solution of ammonic sulphate. The precipitate was found to consist of strontic sulphate. On testing this in a radiant matter tube the citron band was very decided, although much fainter than in the original oxalate. The filtrate was diluted largely, heated, and precipitated with a hot solution of ammonic oxalate; it was then allowed to stand for some time, when a bulky white calcic oxalate came down. This was filtered and washed. Tested in the radiant matter tube, after ignition and treatment with sulphuric acid, it gave the citron band, far exceeding in brightness the spectrum of the original oxalate.

9. So far all the chemical evidence went to show that the band-forming substance was calcium, and further tests tried with the purified oxalate confirmed this inference. Every analytical test to which it was subjected showed lime, and nothing but lime; all the salts which were prepared from it resembled those of lime, both physically and chemically; the flame spectrum gave the calcium lines with extraordinary purity and brilliancy; and finally, the atomic weight, taken with great care, came out almost the same as that for calcium, 39·9 as against Ca 40.

10. I now sought for the citron band amongst other calcium minerals. The preliminary testing was simple. The finely powdered mineral was moistened with strong sulphuric acid, the action being assisted by heat, and the mass was then raised to dull redness (4). It was then put into a radiant matter tube and the induction spark passed through after the exhaustion had been pushed to the required degree.

Treated in this manner most native compounds of lime gave the citron band. A perfectly clear and colourless crystal of Iceland spar converted into sulphate gave it strongly, native calcic phosphate less strongly, and a crystal of arragonite much more brightly. A stalactite of calcic carbonate from the Gibraltar caves gave the band almost as well as calcite, as also did cinnamon stone (lime alumina garnet), iron slag from a blast-furnace, commercial plaster-of-Paris, and most specimens of ordinary burnt lime.

The Citron Band not due to Calcium.

11. Evidence stronger than this in favour of the view that the citron band was an inherent characteristic of calcium could scarcely be; but, on the other hand, there was evidence equally conclusive that the band was not essential to calcium. The ammonia precipitate (5) sometimes gave the citron band with great strength and purity, and although I had not yet obtained this in quantities sufficient for a detailed examination, it was easy to decide that it contained no phosphoric, silicic, or boric acid, fluorine, or other body likely to cause the precipitation of lime in this group. This precipitate must therefore be an earth, and the more carefully I purified it from lime and other substances, the more brilliantly shone out the citron band, and the more intense became the green and red bands.

Another stubborn fact was this:—Starting with a lime compound which showed the citron band, I could always obtain a calcic oxalate which gave the band stronger than the original substance; but if I started with a lime compound which originally gave no citron band, I could never by any means, chemical or physical, constrain the lime or the earthy precipitate to yield a citron band.

12. Among the minerals tried was eudialyte, a silicate of zirconium, iron, calcium, and sodium, containing about 10 per cent of lime. No citron band could be detected on testing the original mineral or any of the constituents separated from it on analysis. This, and a lump of common whiting (levigated chalk), were for some time my only sources of lime which gave no citron band.

13. The only explanation that I could see for this anomaly was that the elusive citron band was caused by some element precipitated with the calcic oxalate, but present in a quantity too small to be detected by ordinary chemical means. I then thought that were I to fractionally precipitate the solution of lime, the band-forming body might be concentrated in one or the other portion. Accordingly the calcic oxalate (7, 8, 9) was ignited and dissolved in hydrochloric acid, and fractionally precipitated in three portions with ammonic oxalate, the first and third portions being comparatively small. They were dried, ignited with sulphuric acid, and tested in the radiant matter tube. All three portions showed the citron band, but the portion which came down first gave the band decidedly the strongest, and the third portion precipitated showed it weakest. This therefore pointed to a difference between calcium and the body sought for. The process, however, was not satisfactory, and I was driven to seek some other method.

14. A portion of an ammonia precipitate found to give the citron band very well (5, 11), was dissolved in dilute sulphuric acid, and the solution evaporated down. Crystals were formed which were difficultly soluble in hot water, but appeared more soluble than calcic sulphate.

A large quantity of the calcic oxalate (7, 8, 9) was ignited with sulphuric acid at a dull red heat, and the resulting calcic sulphate was finely ground and then boiled in a very small quantity of water—not sufficient to dissolve the one-hundredth part of it. The mass was thrown on a filter, and the small quantity of clear liquid which came through was precipitated with ammonic oxalate. The resulting white precipitate was ignited with sulphuric acid, and tested in the radiant matter tube. For the sake of comparison a portion of the calcic sulphate remaining on the filter was also put in a radiant matter tube. The sulphate from the aqueous extract gave the citron band far more brilliantly than the calcic sulphate from the filter. I found, however, that it was impossible, by any amount of washing or boiling out, to deprive the calcic sulphate of all power of giving the citron band, although it was possible in this way to weaken its intensity considerably.

(To be continued.)

ON THE

ESTIMATION OF CUPROUS CHLORIDE IN COPPER LIQUORS.

By S. G. RAWSON, F.C.S.

IN Claudet's process for the extraction of silver from iron pyrites, the presence of any large amount of cuprous chloride in the copper liquors obtained by lixiviation of the calcined ores is very prejudicial. The reason is that the iodide of zinc solution, added for the precipitation of the silver, converts much of the cuprous chloride into cuprous iodide ($Cu_2Cl_2 + ZnI_2 = Cu_2I_2 + ZnCl_2$); and therefore, with an equal volume of solution, much silver is left unacted upon, to obtain which a great excess of zincic iodide over that calculated is requisite. The Cu_2Cl_2 is therefore always determined as a check upon the working of the plant and furnaces; a high temperature in the latter leading to its formation in increased quantities. Three methods for its estimation were examined, viz.—First, oxidation with potassic bichromate, ferricyanide of potassium being the indicator; but this cannot be depended on, owing to the green colour of the solution masking the final stages. Secondly, by means of the addition of potassic sulphocyanide, and causing the cloudiness produced to be removed by ferric chloride, the amount of ferric chloride run in being the measure of the cuprous chloride present. In this case, however, only small quantities of liquor can be used, and the disappearance of the cloudiness is not a sharp enough end-reaction. There only remained oxidation by potassic permanganate, and this with care gave much the best results. The ordinary composition of the copper liquor in grains per gallon, specific gravity = 1·22, temp. = 60° F., is—

Cupric chloride	5690·896
Cuprous chloride..	235·200
Sodic chloride	3797·205
Argentic chloride	3·454
Ferrous chloride	280·034
Hydrochloric acid	536·551
Zincic sulphate	1271·037
Calcic sulphate	139·400
Plumbic sulphate	24·221
Sodic sulphate	10221·563
Insoluble residue..	9·311
Water (by difference)	47791·128
	70000·000

The amount of ferrous chloride varies with the quantity and strength of the free hydrochloric acid, but for every-day work it will be sufficient to estimate it once a week.

The process depends on the fact that in presence of ferric chloride cuprous chloride is converted into cupric chloride, with formation of ferrous chloride; and the equation representing the reaction is—

$$Fe_2Cl_6 + Cu_2Cl_2 = 2CuCl_2 + 2FeCl_2.$$

The permanganate solution contained 300 grains of the salt in 30,000 grains of water, and was standardised against iron-wire containing 9·97 grains Fe per 10 grains of wire, and also against pure ferrous sulphate containing 10·04 grains Fe″ per 50 grains of ferrous sulphate. 5000 grains of water were used throughout. The amount of acid was varied in these experiments to see if any, and in that case how much, difference was caused by its presence in increased quantities, for, so far as I know, no results have appeared on this important point.

		Decems. $Mn_2O_6Ko_2$.
(1) 50 grains SO_2Feo'' + 100 grains SO_2Ho_2	=	59·45
(2) ,, ,, 250 ,,		59·45
(3) ,, ,, 500 ,,		59·50
(4) ,, ,, 1000 ,,		59·50

Even when a solution identical with (3) was freely exposed to the air for an hour it was only slightly oxidised, amount required being 59·35 decems. With iron wire the results were:—

		Decems. $Mn_2O_6Ko_2$.
(1) 10 grns. (9·97) Fe + 250 grains SO_2Ho_2	=	59·00
(2) ,, 500 ,,		59·05
(3) ,, 1000 ,,		59·05

Left in an open flask for thirty-six hours, No. (2) required as much as 58·50 decims., so that a slight interruption in the titration would probably not make much difference. Ten grains of iron wire were also dissolved in 500 grains of hydrochloric acid, but it was difficult to strike the mark within from ½ to ¾ decem., as the colour faded very quickly, and the solution was such a deep yellow that the addition of a little more permanganate did not much change the tint. The times taken to effect solution, as well as the temperatures when titrated, were much varied with but slight differences in the results, though cold solutions were preferable to hot.

From the above figures, taking only the last two determinations in each series, 10·00 grains Fe = 59·275 decems. $Mn_2O_6Ko_2$.

∴ 1 decem. $Mn_2O_6Ko_2$ = 0·29823 grains Cu_2Cl_2.
∴ 10 grains Cu_2Cl_2 should require 33·55 decems. $Mn_2O_6Ko_2$

Cuprous chloride is very slightly soluble in water, though readily so in hydrochloric acid, and I find that if a certain quantity, say 10 grains, is placed in a flask, and there is added 5000 grains of water, and it is allowed to stand for a day or less, that all the chlorine passes into solution as $CuCl_2$, containing the merest trace of Cu_2Cl_2; whilst the residue, which is of a red colour, consists entirely of Cu_2O, the quantity of chlorine present being *nil;* thus—

$$2Cu_2Cl_2 + OH_2 = 2CuCl_2 + Cu_2O + H_2.$$

The amount of copper present in cuprous chloride is theoretically 64·14 per cent; but the mean of several determinations of the salt on which the experiments were made only gave 63·68 per cent, and certainly some of this copper was in the form of the higher chloride, equivalent to a loss of 0·072 grain cuprous chloride on the 10 grains invariably used. Other impurities amounted to 0·144 grain, and this, when added to the deficiency in the copper, equals, per ten grains of chloride, a loss of 0·21 grain Cu_2Cl_2, which represents 0·70 decim. of permanganate, and which therefore must be subtracted from the 33·55 decims. previously found. Therefore, 10 grains Cu_2Cl_2 should require 32·85 decims. of standard permanganate, and this is slightly too high, owing to the presence of the small quantity of cupric chloride detected. With 10 grs. of chloride and 5000 grains of water, the titration in every case being completed in five minutes, the burette readings in decims. were—

10 grains Fe_2Cl_6 +	100	SO_2Ho_2	=	27·30
25 ,,	,,	,,		29·45
50 ,,	,,	,,		31·00
100 ,,	,,	,,		31·50
10 grains Fe_2Cl_6 +	250	SO_2Ho_2	=	27·25
25 ,,	,,	,,		29·30
50 ,,	,,	,,		31·25
100 ,,	,,	,,		32·20
10 grains Fe_2Cl_6 +	500	SO_2Ho_2	=	27·25
25 ,,	,,	,,		29·25
50 ,,	,,	,,		31·20
100 ,,	,,	,,		32·10
10 grains Fe_2Cl_6 +	1000	SO_2Ho_2	=	28·00
25 ,,	,,	,,		30·90
50 ,,	,,	,,		33·10
100 ,,	,,	,,		33·50
50 grains Fe_2Cl_6 +	500	HCl	=	31·70

It will be observed from these figures how steadily the number of decims. run in rose with the amounts of ferric chloride and sulphuric acid added. This is especially noticeable in the last series, and is owing to the fact that

in such strong solutions the sulphuric acid forms ferric sulphate, liberating the chlorine as hydrochloric acid, and thus aiding in the more rapid solution of the cuprous salt; and further, as shown below, the hydrochloric acid so formed interferes very seriously with the reactions in general. When there was not much ferric chloride the permanganate was low, because as soon as the greater portion was reduced to ferrous chloride, the remaining cuprous chloride could only act on the permanganate slowly, and required more time than the five minutes allowed; and, further, the smaller the proportion of ferric chloride the less readily, and in smaller amounts, would ferric sulphate and hydrochloric acid be produced. It is, of course, well known that chlorides are better absent from volumetric determinations in which permanganate is to be employed, but perhaps the following rough quantitative experiments on the rapidity with which different chlorides act may prove interesting.

Solutions were made up to the same volume, and with equal weights of sulphuric acid, and also a much weaker (1 decem. = 0·0884 grain Cu_2Cl_2) permanganate solution was prepared. With the exception of a short interval in its midst twenty-four hours was the time taken:—

(1) 1250 grains $OH_2 + 250\ SO_2Ho_2 = 1·0$ decems. $Mn_2O_6Ko_2$.

(2) 1250 grains $OH_2 + 250\ HCl = 34·0$ decems. $Mn_2O_6Ko_2$.

(3) 1000 grains $OH_2 + 250\ SO_2Ho_2 + 250 HCl =$ 107·0 decems. $Mn_2O_6Ko_2$.

(4) 1250 grains $OH_2 + 250\ SO_2Ho_2 + 25 S_3O_6Fe_2O^{vi} =$ 1·5 decems. $Mn_2O_6Ko_2$.

(5) 1250 grains $OH_2 + 250\ SO_2Ho_2 + 25 Fe_2Cl_6 =$ 47·0 decems. $Mn_2O_6Ko_2$.

(6) 1250 grains $OH_2 + 250\ SO_2Ho_2 + 25 CuCl_2 =$ 75·0 decems. $Mn_2O_6Ko_2$.

In No. 3 eighty decems. were run in at once, showing how rapid was the decomposition, and how great the error which might arise from the presence of a large quantity of free hydrochloric acid.

The colour possessed by No. 1 was that to which all the others were referred. At the expiration of this period, Nos. 1 and 4 were of a bright pink; No. 2, a light brownish pink; No. 3, a brownish pink; No. 5, brown but still pink; No. 6, a purplish blue.

They were then allowed to stand for another day, when No. 1 still retained its colour, but in a lesser degree; Nos. 2 and 3 were quite colourless and clear: No. 4 pink slightly tinged with brown; No. 5 brown; No. 6 an electric blue.

These experiments showed so clearly the superiority of ferric sulphate that it was used instead of ferric chloride, and the results—only a few of which I give—were more satisfactory, both as regards their concordance and the permanency of the colour, which in all the ferric chloride solutions had been very fleeting.

25	grains	$S_3O_6Fe_2O^{vi}$	$+250\ SO_2Ho_2$	$=29·70$
50	,,	,,	,,	30·10
50	,,	,,	$+500\ SO_2Ho_2$	$=30·50$
100	,,	,,	$+250\ SO_2Ho_2$	$=31·75$
100	,,	,,	$+500\ SO_2Ho_2$	$=32·20$
100	,,	,,	$+1000\ SO_2Ho_2$	$=32·30$

The best way to dissolve the ferric salt is to add sulphuric acid to it until it is in a pasty condition, and then to mix it with cold water: on no account should this be boiling or even hot. Perhaps a useful strength is 9800 grains of water and 200 grains sulphuric acid per 1000 grains of sulphate, and it should be allowed to stand for some time before being used, as a slight sediment usually settles out. The addition of a little ferrous sulphate will render it much more soluble, but the solution must then be standardised once a day at least, and a measured quantity run into the copper liquor, owing to the presence of this ferrous salt.

Many tests were made of solutions to which cupric chloride had been added together with sodic sulphate and chloride, and the various other salts found in the normal copper liquors. There was, however, but little perceptible difference caused by the presence of these substances, except in the case of much free hydrochloric acid. Then the titration should be performed with some quickness, and should be considered as finished on the first appearance of the pink colour, for the solution will turn green again very rapidly, owing to the action of the acids on one another. It is on this account that I prefer ferric sulphate to ferric chloride (though Sutton recommends the latter), as the oxidising agent, to avoid as far as possible the disturbing influence which chlorides exert on the end-reaction of the permanganate. It also seems better that the sulphuric acid, which is obliged to be used (among other ways I tried to work, but quite unsuccessfully,—(1) without sulphuric acid, (2) with acetic acid, (3) with tartaric acid) should only be added when everything else is ready, and then in the smallest quantity, and that a large excess of ferric sulphate should be taken. None of the observations are quite as high as might be looked for, because of the difficulty of getting all the cuprous chloride into solution, which is certainly not attained in so short a time as five minutes. I adopted this time, however, as being about that which would be given in an ordinary laboratory, and in the copper liquors themselves this error on the low side would be compensated for in two ways, both because cuprous chloride is much more soluble in cupric chloride and hydrochloric acid than in water; and, secondly, because the action of the sulphuric acid on the chlorides and hydrochloric acid will also tend to raise the readings. In fact I should be disposed to say that, if anything, the amount of cuprous chloride found would be too high rather than too low.

St. Helens, Lancashire.

ON THE

PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Continued from page 156.)

Action of the Stomach and Intestine upon Cane Sugar.

Through the researches of Bernard, cane sugar has been known to be susceptible of being changed in the digestive canal. The description given is that the small intestine contains a ferment which has the effect of converting cane sugar into glucose, and that this ferment does not exist elsewhere within the digestive system.

Such is the statement that I had before me in starting upon the enquiry about to be set forth. If the assertion were true that cane sugar is thus converted into glucose, it would conflict with what I have shown to occur in the case of glucose. That glucose should be moved into a lower cupric oxide reducing body, and cane sugar at the same time moved into glucose, certainly appears contradictory. I will proceed to show how the matter in reality stands.

The evidence upon which the assertion is grounded that cane sugar is converted into glucose by the action of a ferment contained in the small intestine is that a body is produced which reduces the oxide of copper. No further inquiry than that afforded by testing with the copper test was formerly adopted, but it is now manifest that more than this is required to show what the body produced really consists of. I have submitted the matter to a full investigation, and will bring forward the results obtained to speak for themselves. The order I shall adopt is first the consideration of where the capacity exists for effecting a transformation, and next the nature of the transformation that occurs.

As cane sugar exerts no reducing action upon the copper test, the development of a cupric oxide reducing

* A Paper read before the Royal Society, Dec. 20th, 1883.

body in the product of experiment suffices to show that a transformation has been effected. It is only for determining the nature of the cupric oxide reducing body produced that the necessity exists for putting into practice the treatment with sulphuric acid, and comparing the reducing power after with that before. In all my experiments, however, this has been done, but to put the matter forward in as simple a form as possible I will not introduce unnecessary figures.

The subjoined experimental evidence obtained from various animals shows in an unequivocal manner that a transformative power is possessed by the stomach as well as by the intestine. It is true the energy of the intestine is very much greater than that of the stomach. This will be seen from the quantitative determinations deduced. The transformative energy possessed by the intestine produces so strong an effect as to render itself readily susceptible of recognition through coarse quantitative testing, and thus it did not escape the notice of Bernard. The less degree of energy, however, possessed by the stomach became overlooked.

Experiment.—A solution of cane sugar was placed in the thoroughly-cleansed stomach of a recently-killed rabbit, and the stomach immersed in about 100 cub. centims. of water contained in a beaker. The beaker and its contents were then exposed for thirty minutes to a temperature of 120° F. (48·8° C.), and afterwards placed aside in the laboratory for twenty-four hours. Some of the water was taken from the beaker for analysis at the end of the thirty minutes, and the remainder analysed at the end of the twenty-four hours. The contents of the stomach were also removed at the end of the twenty-four hours, and subjected to analysis. Precisely the same procedure was adopted with the intestine, and here duplicate observations were conducted. The cupric oxide reducing power belonging to the several products was ascertained, and the subjoined figures show the respective amounts of glucose to which it was equivalent.

	Cupric oxide reducing power expressed as glucose.
Stomach.	
Water in beaker after thirty mins. ..	Trace.
,, ,, twenty-four hrs.	0·084 grm.
Contents of stomach after ,, ,,	0·088 ,,
Intestine.	
I. Water from beaker after thirty minutes	0·082 ,,
,, ,, 24 hours ..	0·400 ,,
Contents of intestine after ,, ...	0·500 ,,
II. Water from beaker after thirty minutes	0·082 ,,
,, ,, 24 hours. ..	0·262 ,,
Contents of intestine after ,, ...	0·832 ,,

Experiment.—Some of the scrapings from the mucous membrane of the cleansed stomach of a pig were boiled to destroy the ferment, and then mixed with 20 cub. centims. of cane sugar solution.

Some of the same scrapings without being boiled were mixed with the same quantity of the solution of cane sugar, and then exposed for one hour to a temperature of 120° F.

Scrapings from the mucous surface of the intestine were dealt with in a precisely similar manner.

The products were treated with sulphate of soda, and submitted to the usual process of analysis with the following results:—

	Cupric oxide reducing power expressed as glucose.
Stomach.	
Portion boiled and 20 cub. centims. of cane sugar solution (=0·302 grm. glucose) added	0·000 grm.
Portion exposed one hour to 120° F. with 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose)..	0·032 ,,
Intestine.	
Portion boiled, and 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose) added	0·000 grm.
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose)	0·082 ,,

Experiment.—Scrapings from the mucous membrane of the cleansed stomach of a horse were mixed with water, so that they could be measured out for employment.

Three portions of 20 cub. centims. each were taken. The first was boiled, and then mixed with 20 cub. centims. of a solution of cane sugar, equivalent to 0·570 grm. of glucose. The second was at once mixed with 20 cub. centims. of the same solution of cane sugar, and then exposed for one hour to a temperature of 120° F. The third was mixed with 5 cub. centims. of the cane sugar solution, equivalent to 0·142 grm. of glucose, and likewise exposed for one hour to a temperature of 120° F.

A counterpart proceeding was carried out with the scrapings from the mucous membrane of the intestine of the same horse. The several products were treated with sulphate of soda, and subjected to quantitative analysis, with the following results:—

	Cupric oxide reducing power expressed as glucose.
Stomach.	
Portion boiled, and 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) added..	0·000 grm.
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) ..	0·012 ,,
Portion exposed for one hour to 120° F., with 5 cub. centims. of a solutions of cane sugar (=0·142 grm. glucose) ..	0·012 ,,
Intestine.	
Portion boiled, and 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) added..	0·000 ,,
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) ..	0·200 ,,
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·142 grm. glucose) ..	0·118 ,,

Experiment.—Some scrapings from the mucous membrane of the cleansed stomach of a dog were mixed with 10 cub. centims. of a solution of cane sugar, containing cane sugar equivalent to 0·464 grm. of glucose, and exposed for eighteen hours to the ordinary temperature. A parallel proceeding was undertaken with the intestine.

The following are the results that were obtained:—

	Cupric oxide reducing power expressed as glucose.
Stomach with cane sugar solution (=0·464 grm. glucose) stood eighteen hours ..	0·010 grm.
Intestine with cane sugar solution (=0·464 grm. glucose) stood eighteen hours ..	0·226 ,,

Experiment.—The inner surface of the cleansed stomach of a recently killed cat was scraped off and mixed with water, so that measured quantities could be taken. The same was done with the intestine; varying quantities were then exposed as mentioned below, in contact with 5 cub. centims. of a solution of cane sugar, in which the amount of cane sugar present stood equivalent to 0·250 grm. of glucose. The subjoined figures show the results obtained. Although not mentioned in the details given in each case (as also in all the other experiments I have made) the product was titrated before and after sulphuric acid, and the result obtained after treatment with sulphuric acid showed

that the amount of carbohydrate present stood equivalent to 0·250 grm. of glucose, in accordance with the representation given of the amount of cane sugar present in the 5 cub. centims. of cane sugar solution used. This double determination furnishes an important check upon the accuracy of the individual results obtained.

	Cupric oxide reducing power expressed as glucose.
20 cub. centims. of stomach product with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·020 grm.
40 cub. centims. of stomach product, with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·036 ,,
20 cub. centims. of intestinal product with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·072 ,,
20 cub. centims. of intestinal product with 50 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F., and afterwards allowed to stand eighteen hours at ordinary temperature	0·190 ,,
40 cub. centims. of intestinal product with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·138 ,,
60 cub. centims. of intestinal product with 50 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F...	0·150 ,,

Condition in the Ruminant.

I have already adverted to the peculiarity in the position of the ferment in the digestive tract of the ruminant which acts upon grape sugar, and shown that whilst in other animals it is situated in the stomach and intestine, in the ruminant it is found in the paunch, reticulum, and many-plies, and not in the true stomach and intestine. With reference to cane sugar also, the conditions are different. The stomach in animals generally contains much less ferment than the intestine. In the ruminant the amount of ferment in the true stomach is still less. The great difference, however, is in the intestine. Whilst the intestine of the horse, pig, &c., possesses an energetic transformative influence over cane sugar, it is striking to notice in a parallel experiment with the sheep that practically almost no change is induced. It is in the parts of the stomach before the true stomach is reached that the capacity exists for exerting the change which cane sugar undergoes in the alimentary tract.

Experiment.—Portions of the cleansed paunch, reticulum, many-plies, and reed or true stomach of a sheep were minutely divided, and 10 grms. of each taken. After the addition of a little water they were respectively mixed with 5 cub. centims. of a solution of cane sugar containing an amount of cane sugar equivalent to 0·104 grm. of glucose. They were now exposed for two hours to a temperature of 120° F., and then prepared in the usual way for titration with the ammoniated cupric test.

Portions of sheep's intestine were also dealt with according to the details furnished below.

The subjoined figures show the results obtained :—

	Cupric oxide reducing power expressed as glucose.
Paunch with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 190° F.	0·086 grm.
Reticulum with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 120° F.	0·020 ,,
Many-plies with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 120° F.	0·068 grm.
Reed (true stomach) with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 120° F..	0·016 ,,
Intestine with 10 cub. centims. of a solution of cane sugar (=0·208 grm. glucose) exposed for two hours to 120° F.	trace.
Intestine with 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose) stood eighteen hours at ordinary temperature	0·006 grm.
Intestine with 10 cub. centims. of a solution of cane sugar (=0·416 grm. glucose) exposed forty-five minutes to 120° F., and afterwards allowed to stand eighteen hours at the ordinary temperature.. ..	0·014 ,,

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

SELENIUM.

The atomic weight of this element was first determined by Berzelius,† who, saturating 100 parts of selenium with chlorine, found that 179 of chloride were produced. Further on these figures will be combined with similar results by Dumas.

We may omit, as unimportant for present purposes, the analyses of alkaline selenates made by Mitscherlich and Nitzsch,‡ and pass on to the experiments published by Sacc|| in 1847. This chemist resorted to a variety of methods, some of which gave good results, while others were unsatisfactory. First, he sought to establish the exact composition of SeO_2, both by synthesis and by analysis. The former plan, according to which he oxidised pure selenium by nitric acid, gave poor results; better figures were obtained upon reducing SeO_2 with ammonium bisulphite and hydrochloric acid, and determining the percentage of selenium set free :—

0·6800 grms. SeO_2 gave	0·4828 grms. Se.	71·000 per cent.
3·5227 ,,	2·5047 ,,	71·102 ,,
4·4870 ,,	3·1930 ,,	71·161 ,,
		Mean 71·088 ± 0·032

In a similar manner Sacc also reduced barium selenite, and weighed the resulting mixture of barium sulphate and free selenium. This process gave discordant results, and a better method was found in calcining $BaSeO_3$ with sulphuric acid, and estimating the resulting quantity of $BaSO_4$. In the third column I give the amounts of $BaSO_4$ equivalent to 100 of $BaSeO_3$:—

0·5573 grm. $BaSeO_3$ gave	0·4929 $BaSO_4$.	88·444
0·9942 ,,	0·8797 ,,	88·383
0·2351 ,,	0·2080 ,,	88·473
0·9747 ,,	0·8621 ,,	88·448
		Mean 88·437 ± 0·013

Still other experiments were made with the selenites of silver and lead; but the figures were subject to such errors that they need no further discussion here.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1. 1826.
‡ *Ibid.*, 9, 623. 1827.
|| *Ann. d. Chim. et d. Phys.*, (3), 21, 119.

A few years after Sacc's work was published, Erdmann and Marchand made with their usual care a series of experiments upon the atomic weight under consideration.* They analysed pure mercuric selenide, which had been repeatedly sublimed and was well crystallised. Their method of manipulation has already been described in the chapter upon mercury. These percentages of Hg in HgSe were found :—

71·726
71·731
71·741

Mean 71·7327 $\pm$ 0·003

The next determinations were made by Dumas,† who returned to the original method of Berzelius. Pure selenium was converted by dry chlorine into $SeCl_4$, and from the gain in weight the ratio between Se and Cl was easily deducible. I include Berzelius's single experiment, which I have already cited, and give in a third column the quantity of chlorine absorbed by 100 parts of selenium :—

1·709 grms.	Se absorb	3·049 Cl.	178·409
1·810	,,	3·219 ,,	177·845
1·679	,,	3·003 ,,	178·856
1·498	,,	2·688 ,,	179·439
1·944	,,	3·468 ,,	178·395
1·887	,,	3·382 ,,	179·226
1·935	,,	3·452 ,,	178·398
			179·000—Berzelius.

Mean 178·696 $\pm$ 0·125

The question may here be properly asked, whether it would be possible thus to form $SeCl_4$ and be certain of its absolute purity? A trace of oxychloride, if simultaneously formed, would increase the apparent atomic weight of selenium. In point of fact, this method gives a higher value for Se than any of the other processes which have been adopted, and that value has the largest probable error of any one in the entire series. A glance at the table which summarises the discussion at the end of this chapter will render this point sufficiently clear.

Latest of all, we come to the determinations made by Ekman and Pettersson.‡ They tried various methods of investigation, and finally decided upon the two following :—

First. Pure silver selenite, Ag_2SeO_3, was ignited, leaving behind metallic silver in the subjoined percentages :—

62·93
62·95
62·97
62·94
62·98
62·98
62·95

Mean 63·957 $\pm$ 0·005

Second. A warm aqueous solution of selenious acid was mixed with HCl, and reduced by a current of SO_2. The reduced Se was collected upon a glass filter, dried, and weighed. Percentages of Se in SeO_2 :—

71·199
71·185
71·193
71·187
71·191

Mean 71·191 $\pm$ 0·0016

This series, combined with that of Sacc, 71·088 $\pm$ 0·032, gives a general mean of 71·1907 $\pm$ 0·0016.

There are now five series of figures from which to deduce the atomic weight of selenium :—

(1). Per cent of Se in SeO_2, 71·1907 $\pm$ 0·0016
(2). $BaSeO_3 : BaSO_4$: : 100 : 88·437 $\pm$ 0·013
(3). Per cent of Hg in HgSe, 71·7327 $\pm$ 0·003
(4). Se : $SeCl_4$: : 100 : 178·696 $\pm$ 0·125
(5). Per cent of Ag in Ag_2SeO_3, 62·957 $\pm$ 0·005

From these we get the following values for selenium :—

From (1)	Se = 78·894 $\pm$	0·018
,, (2)	,, 78·362	0·053
,, (3)	,, 78·700	0·019
,, (4)	,, 79·174	0·064
,, (5)	,, 78·819	0·025
General mean ..	,, 78·797	0·011

If O = 16, Se = 78·978.

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Anniversary Meeting, Monday, March 31, 1884.

The President, Dr. W. H. Perkin, F.R.S., read his annual report. The number of Fellows at the last Anniversary was 1247: the present number is 1324, or an increase during the year of 77. The loss sustained by death has been exceptionally great, the following having died during the past twelve months :—R. R. F. Davey, W. Grant, W. Griffin, J. Hogarth, G. M. Hopwood, E. Hunt, C. H. Hutchinson, W. A. Peake, T. Pearsall, W. Plunkett, G. B. Robertson, Sir C. W. Siemens, F. Slinger, J. Hill Smith, W. Spottiswoode, J. T. Way, J. Young. The rooms of the Society have been re-decorated. Many additions have been made to the library, and it is hoped that the new catalogue will be completed by the end of the session. The collection of autotype portraits of Past Presidents is almost complete, and is on view in the Council room.

The President then handed the Longstaff Medal to Mr. O'Sullivan as the Fellow who, in the opinion of the Council, had done most to promote Chemical Science by research during the last three years.

Sixty-seven papers have been read before the Society since the last anniversary.

The President then referred briefly to some of the most important advances in chemical science during the year. The numerous determinations and re-calculations of atomic weights by Clarke, Lothar Meyer, Brauner, Thorpe, Dewar and Scott, &c.; the use of boiling oxygen and ethylene as refrigerating media; the freezing of alcohol at $-130°$; the use of hydroxylamine as a reagent in organic chemistry, by Victor Meyer and his pupils; the improvements in the preparation of this substance by Divers, &c.; the numerous researches of Baeyer on the constitution of indigo, which may be represented—

```
C6H4—CO   CO—C6H4
  |    .|    |    |
HN   —C  =  C   —NH
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(the President remarked that although there are now several processes by which this colouring matter can be manufactured, it cannot as yet be produced at a sufficiently low price to compete with the natural product); the work of Lewkowitsch on mandelic acid; of Hofmann on pentamethyl-anilin; of Victor Meyer on thiophene, &c., were also briefly described.

The address concludes with some considerations as to the influence the increasing number of laboratories and the greater facilities for the study of chemistry have had on the development of chemical science in this country. The first thing that attracts attention is the startling and

* *Journ. f. Prakt. Chem.*, 55, 202. 1852.
† *Ann. Chem. Pharm.*, 113, 32. 1860.
‡ *Ber. d. Deutsch. Chem. Gesell.*, 9, 1210. 1876. Published in detail by the society at Upsala.

anomalous fact that the number of papers read before the Society is declining year by year. In 1880-1 it was 113; in 1881-2, 87; in 1882-3, 70; and last year it was 67. The work of our laboratories at the Universities, Colleges, and Hospitals seems to consist mainly in studying the ordinary course of qualitative and quantitative analysis, and in attending one or two courses of lectures. Such an education is insufficient; it is only a preliminary part of the training. The subsequent prosecution of scientific research under proper supervision calls out all the faculties of the student, requiring independent thought, and gives an insight and vivid interest in the science which nothing else can do. In Germany the degree of Doctor of Philosophy has undoubtedly done much, as it necessitates the prosecution of original work; and now that degrees are so highly thought of in this country (though why a chemist with one of our ordinary degrees should be preferred to one who has fully given his mind to his science, and therefore has not such a degree, it is difficult to understand), it is believed that if something analogous to the Ph.D. degree could be inaugurated in this country it would help the further advance of chemical science in this country. It is said that students cannot be induced to stay longer than is necessary to go through the ordinary course of analysis, and can this be wondered at when they do not see anything else going on of sufficient interest to make them feel that it would be a great advantage for them to stay? Would it be the case if higher work were being enthusiastically carried on? The fact that many of our students leave this country for Germany, where research is carried on with so much zeal, is a sufficient answer to this question. In conclusion, the President expressed a hope that at the Central Institute of the City and Guilds of London chemists would be trained in such a way as not only to carry out existing processes, but also to advance the chemical industries of the country by suggesting improvements and new processes, so that these industries might flourish and at least keep abreast of those on the Continent.

Dr. Gladstone said that it was his agreeable duty to propose a vote of thanks to the President, and at the same time to move that his address, which had been so enthusiastically received, be printed.

The vote was seconded by Mr. Howard, and carried unanimously.

The Treasurer then read his report. The total income of the Society was £4732 16s. 4d. The expenses, including the purchase of £300 stock, amounted to £3028 1s. 9d., leaving a balance in the bank of £1704 14s. 7d. The balance was larger than had been anticipated, because an unusual number of Fellows elected during the year had paid life compositions, and because the new catalogue had not yet been completed. The principal items in the expenditure are—*Journal*, £1591; Library, £241; re-decoration of rooms, £294; houses expenses, £185; commission, £145. The assets of the Society amount to £9792 14s. 7d. As to the Research Fund—Receipts amounted to £431; grants, £95; balance, £336; assets, £4836 3s. 3d.

Votes of thanks were proposed to the Treasurer, the Auditors, the Officers and Council, and the Editor, Sub-Editor, and Abstractors.

After a ballot the Scrutineers, Messrs. Greenaway and Williams, declared the following Officers and Council duly elected:—

President—W. H. Perkin, Ph.D., F.R.S.

Vice-Presidents—Sir F. A. Abel, Warren De la Rue, E. Frankland, J. H. Gilbert, J. H. Gladstone, A. W. Hofmann, W. Odling, Sir Lyon Playfair, H. E. Roscoe, A. W. Williamson, P. Griess, G. D. Liveing, E. Schunck, T. E. Thorpe, A. Voelcker, W. Weldon.

Secretaries—H. E. Armstrong, J. Millar Thomson.

Foreign Secretary—H. Müller.

Treasurer—W. J. Russell.

Members of Council—E Atkinson, H. T. Brown, T. Carnelly, M. Carteighe, R. J. Friswell, W. R. E. Hodgkinson, D. Howard, F. R. Japp, R. Meldola, R. Messel, C. O'Sullivan, C. Schorlemmer.

Ordinary Meeting, Thursday, April 3, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—R. St. Stephens and R. C. Tresidder.

Prof. P. T. Clève, of Upsala, was present at the meeting, and was formally admitted as a Foreign Member.

Mr. Salamon read a paper "*On the Influence of certain Phosphates upon Vinous Fermentation*," by A. G. Salamon and W. de Vere Mathew. Considerable difficulty is often experienced in the course of the manufacture of beer by the method of high fermentation in producing a sufficient attenuation of the wort in a given time. Under such circumstances it is constantly urged that the addition of certain salts of phosphoric acid will exercise such a stimulating influence upon the growth of the yeast organism as to materially increase the rapidity of the attenuation of the wort. The authors undertook the present series of experiments to determine whether such a stimulation is really obtained. They have estimated the vigour of the fermentation by the amount of sugar consumed in a given time, the sugar left after the fermentation being determined gravimetrically, as recommended by O'Sullivan. The following Pasteur solution was used as a fermenting medium:—Water, 100 c.c.; potassium phosphate, 0·233 gramme; calcium phosphate, 0·02 grm.; magnesium sulphate, 0·023 grm.; ammonium tartrate, 1·166 grm.; cane-sugar, 17·490 grms. The temperature of the solutions was maintained at 60° F., and the duration of the experiments was usually 60 hours. The following may be given as an example of the experiments. 100 c.c. of Pasteur solution were used with 5 grms. of pressed yeast:—

Sugar consumed in grammes per 100 c.c.	Potassium Phosphate in grammes per 100 c.c.
8·5770	0·0000
8·5896	0·0575
8·5001	0·1150
8·7666	0·1720
9·6884	0·2300 (=0·0770 P_2O_5)
9·9124	0·2875
7·7586	0·3450
7·5948	0·4025
7·8878	0·4600
7·2850	0·5175

Time, forty-eight hours.

It is seen that the maximum fermentation occurs when 0·23 grm. of potassium phosphate are present per 100 c.c., which is the normal amount in Pasteur's solution; a larger quantity is obviously fatal to the proper activity of the yeast ferment. Similar experiments proved that although small quantities of calcium and magnesium phosphates were beneficial an excess was most injurious. Now the normal amount of P_2O_5 in an English beer wort is about 0·1160 grms., and in the normal Pasteur solution 0·0875. The ordinary wort contains, therefore, an excess of P_2O_5 over that which has been found to be most favourable to fermentation. Hence it follows that it is not advisable to add phosphates for the purpose of accelerating the attenuation of ordinary beer worts.

The President asked if the authors had made any experiments to decide whether the alteration in activity was due to the potassium salts or the phosphoric acid.

Mr. Warington said that in the tables where the authors had stated the phosphoric acid as 0·00 grm. the P_2O_5 in the yeast still had to be taken into account, because probably if no P_2O_5 were present no yeast growth or transformation of sugar would take place. It seemed that it was not at all proved that the action was due to the phosphoric acid. It would be interesting to know what

would happen if another salt, as potassium sulphate, was substituted for potassium phosphate.

Mr. Salamon said that their object was to ascertain whether it was advisable to add phosphates to the wort or not, and from their experiments it seemed that this question must be answered in the negative.

The Secretary then read a paper "*On the Occurrence of Rhabdophane in the United States*," by W. N. Hartley. In the *American Journal of Science*, xxv., 459, Brush and Penfield describe a new mineral from Salisbury, Conn., under the name of Scovillite. This mineral agrees in physical properties, &c., with rhabdophane (*Chem. Soc. Jour. Trans.*, xli., 210), and seems to be a variety of that mineral, containing erbium and yttrium, associated with lanthanium carbonate. In a subsequent number of the *American Journal of Science* (March, 1884) Brush and Penfield have recognised this identity of scovellite with Rhabdophane.

The Society then adjourned to April 17, when a paper "On the Synthesis of Galena," by Emerson Reynolds, will be read.

CORRESPONDENCE.

AN IMPOSTOR.]

To the Editor of the Chemical News.

Sir,—Professor Hartley's warning given in the Chemical News, vol. xlix., p. 147, reminds me of a visit paid to me by a German representing himself as the son of Dr. C. R. Fresenius, of Wiesbaden, some few weeks since. His story was to the effect that he was taking a holiday in this country, and had recently been the guest of Professor Roscoe, who had shown him many kind attentions. Upon his arrival in town he found that his only personal acquaintance here, viz , Dr. A. W. Williamson, was absent, and being temporarily inconvenienced by the non-arrival of an expected remittance from home, he appealed to me, with profuse apologies, for what must, he said, appear somewhat extraordinary conduct, to relieve him from his difficulty, which, by the way, was extremely well devised and effectively explained. Instead of discharging any obligation he may be under to me, he has no doubt passed on to new fields of action.—I am, &c.,

C. T. Kingzett.

Trevena, Amhurst Park, N.
April 4, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 7, February 18, 1884.

The President announced the loss sustained by the Academy by the decease of Count Theodor du Moncel, which took place on February 16th.

Reciprocal Displacements between Hydrofluoric Acid and the other Acids.—MM. Berthelot and Guntz. If a current of dry gaseous hydrochloric acid is passed in the cold into dry potassium fluoride contained in a platinum boat, the hydrochloric acid is absorbed without an escape of hydrofluoric acid, and there are formed potassium chloride and fluorhydrated potassium fluoride. With the nitric and sulphuric acids the results are similar. Hydrofluoric acid is partially expelled by acetic acid and also by oxalic and tartaric. All these facts are foreseen and explained on thermo-chemical principles.

Law of Modules, or Thermic Substitution-Constants.—M. Berthelot.—The author shows that this law does not hold good for the soluble salts of mercury.

On Fluorhydrated Potassium Fluoride and on its States of Equilibrium in Solutions.—M. Guntz.—This thermo-chemical memoir does not admit of useful abstraction.

Nitro-Derivatives of Ethylene Hydride.—M. A. Villiers. The author has previously described a first reduction-derivative of the potassium compound of tetranitrous ethylene bromide obtained by treatment with ammonium hydrosulphate. He has pursued the reductive action of hydrogen sulphide further, and has obtained a well-defined base, which he has not yet found opportunity to analyse. He has also studied the action of sulphurous acid upon the potassium compound of tetra-nitrous ethylene bromide.

Probable Number of Homologues and Isomeric Rosanilines.—MM. A. Rosenstiehl and M. Gerber.—From the experimental data furnished by M. Hofmann and the authors they conclude that nine rosanilines have been prepared, six homologues and three isomers. This number, however, they consider is but a fraction of those whose existence may be foreseen, and which probably amount to thirty.

New Compound obtained whilst Preparing Benzine Hexachloride.—J. Meunier.—The new compound has the same percentage composition as the ordinary benzine hexachloride. It forms octahedral crystals, which melt only at about 300°. Potassium cyanide dissolved in alcohol splits up the ordinary hexachloride but leaves the new compound untouched.

Constitution of Milk.—E. Duclaux.—The author, instead of the present methods of determining albumen and lactoproteine proposes to determine the caseine which passes through (unglazed) porcelain, and to which he gives the name of dissolved caseine in contradistinction to suspended caseine. He separates the soluble caseine from the two other forms by aspirating the milk through porous battery cells, selecting the smallest and the most homogeneous. The fatty matter, the two other forms of caseine, and a part of the calcium phosphate are left behind, whilst the milk-sugar, the dissolved caseine, and residue of the calcium phosphate and the other mineral salts pass through the porous material.

No. 8, February 25, 1884.

Equilibria between Hydrochloric and Hydrofluoric Acids.—MM. Berthelot and Guntz.—These two acids may displace each other reciprocally in consequence of the formation of fluorhydrates of the fluorides, both in the anhydrous and in the hydrated condition. This salt is partially dissociated by the water which dissolves it, the real proportions of acid and of fluoride combined varying according to the relative excess of the two components. They show that the various degrees of dissociation of the fluorhydrate regulate the equilibria between the two hydracids themselves. All this demonstration is the same which has been given by M. Berthelot for the reciprocal displacements, and the equilibria between sulphuric and hydrochloric acids. (See *Essai de Mécanique Chimique*, vol. ii., p. 638.

On the Reduction of the Congelation Point of Solutions of the Alkaline Salts.—F. M. Raoult.—In the author's tables of results the salts have been divided into five groups according to the number of atoms of metal contained in each saline molecule. The different salts in each group present approximately the same molecular lowering of the point of congelation.

Formation-Heat of the Mercury Oxybromides.—G. Andre.—The formation-heat of the mercury oxybromides is a little inferior to that of the corresponding compounds of lead and equally inferior to that of the mercury oxybromides of the same formula.

Determination of the Carbonic Acid of the Air effected by the Expedition to Cape Horn.—MM. A. Muntz and E. Aubin.—A description of the method of operation and a figure of the apparatus employed. It appears from the results obtained that at Cape Horn the proportions of carbonic acid in the air are very distinctly lower than those observed in Europe. The general mean of the observations is 2·56 of carbonic acid in 10,000 vols. of air, whilst the mean of determinations made in the northern hemisphere, at stations respectively remote from each other, is 2·84.

Formation-Heat of Antimony Chloride and Oxychlorides.—M. Guntz.—For the chloride the author adopts the value + 47·4 cal. For the oxychloride, SbO_2Cl, + 19·33 cal.

Synthesis of the Pyridic and Piperidic Bases.—A. Ladenburg.—The bases of the pyridic series are tertiary bases. They combine with the alcoholic iodides to form quaternary iodides. If these iodides are heated to 290° they are partially transformed into tertiary bases homologues of the pyridine employed. By this reaction there are always obtained two isomeric bases, one of which, the larger in quantity, belongs to the series γ, whilst the other, with a higher boiling-point, belongs probably to the series α.

Addition of Iodine Chloride to Monochlorated Ethylene.—L. Henry.—Monochlorated ethylene is absorbed more slowly than ethylene itself by the aqueous solution of iodine chloride. The resulting product falls to the bottom of the liquid as a slightly brownish oil, $C_2H_3Cl_2I$. Its spec. grav. at 0° = 2·2187; it boils under a pressure of 774 m.m. at 171° to 172°, taking a slightly violet colour.

A New Splitting-up of Ethyl Carbamate.—G. Arth.—The author finds that the reaction observed by M. Haller (*Comptes Rendus*, xcii, p. 1511, and xciv., p. 869), is general, and that all the carbamic ethers can be split up in a similar manner.

Ethyl and Ethyl Methyl-acetyl-cyanacetate.—A. Held.—The new compound is a colourless liquid of an ethereal odour, insoluble in water and alkalies, of spec. grav. 0·996 at + 20°, and boiling at 90° to 95° under a pressure of 15 to 20 m.m.

Action of Bromated Ethylene upon Benzol in presence of Aluminium Chloride.—MM. Hanriot and Guilbert.—The two products obtained by this reaction are styrolyle bromide and di-ethylbenzol dibromide.

Action of Rennet upon Milk.—E. Dulaux.—In spite of the addition of rennet, a part of the colloidal caseine of the milk, 0·46 per cent, does not change its condition and does not, like the rest, pass into the form of solid caseine. The portion remaining untouched diminishes if the dose of rennet increases, but it never becomes null. Milk is a system in which the three forms of caseine are in a state of stable equilibrium as regards each other. This state of equilibrium may be disturbed by the addition of minute quantities of different substances, such as mineral salts and diastases. Rennet modifies it in favour of solid caseine and casease in favour of dissolved caseine.

Researches on the Fermentation of Dung.—U. Gayon.—In reference to the memoir of P. P. Dehérain (*Comptes Rendus* of Feb. 11th), the author observes that dung is capable of two quite different fermentations according as it is exposed to the open air or shut up in a closed place. In the former case it is the seat of energetic oxidation which raises the temperature and produces carbonic acid; in the second case it retains its original temperature and evolves a mixture of carbonic acid and of formene. In comparative experiments performed with 250 kilos. of recent horse-dung placed respectively in a well ventilated chest, and in one tightly closed, the temperature rose in the former to 74°, whilst in the latter its maximum was 22°. From the ventilated dung there escaped "torrents of ammonia." As the mass became dry the oxidation ceased and the thermometer fell. If the surface was watered the combustion re-commenced and the temperature rose.

Die Chemische Industrie.
Vol. vii., No. 2, February, 1884.

Two Sodium Calcium Carbonates in the Alkali Manufacture.—Dr. C. Reidemeister.—The author points out that in addition to the crystals of Gay-Lussite (sodium-calcium carbonate) forming in soda-lyes there were also occasionally other crystals which differ from Gay-Lussite crystallographically and chemically, as was determined by Professors Arzruni and Rammelsberg. The formula of Gay-Lussite is $Na_2CO_3+CaCO_3+5aq$. The newly-distinguished form is $2(Na_2CO_3+CaCO_3)+5aq.$, or, in other words, it contains only half as many mols. of water. As regards the conditions under which the one or the other hydrate is formed it is remarked that the compound richer in water (Gay-Lussite) is produced at lower temperatures below 40°, and from a more dilute solution of crude soda. The compound poorer in water is produced at temperatures above 40° and at a higher concentration. A solution which, in the settling troughs may deposit Gay-Lussite on heating or carbonisation may yield the second compound.

Cosmos les Mondes,
No. 5, February 2, and No. 7, February 16.

These numbers contain no chemical matter.

MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—In addition to the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, and Architect T. Brahm. The assistants in the laboratory in the Winter Term 1883-4 were fourteen in number and in the Versuchsstation two. Last Term there were 65 students on the books. Of these, 40 were from Germany, 7 from England, 4 from North-America, 3 from Austro-Hungary, 2 from Switzerland, Luxembourg, and Sweden, 1 from Holland, Belgium, France, Spain, and Russia. The establishment has been enlarged by a special department for practical work in organic chemistry. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

Albumenoids of Milk.—E. Duclaux.—The author points out that caseine is as yet very ill-defined. If we give the name to whatever is precipitated by dilute acids, alcohol, or rennet, we omit to say that in one and the same milk these various reagents precipitate very unequal quantities of matter, and, besides that, one and the same reagent throws down very different proportions according to the temperature, the dilution, the nature, and proportion of the dissolved salts, &c. The author maintains that the albumen of milk, the lactoproteine, as well as the less known bodies, albuminose, galactine, &c., are merely forms of true caseine, insoluble in feebly acid liquids.—*Comptes Rendus*, No. 6.

MEETINGS FOR THE WEEK

TUESDAY, 15th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
WEDNESDAY, 16th.—Meteorological, 7.
THURSDAY, 17th.—Chemical, 8. Ballot. "On the Synthesis of Galena by means of Thio-carbamide," by J. Emerson Reynolds, F.R.S. "Analysis of Woodall Spa," by W. T. Wright and T. Burton.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1273.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Continued from p. 160).

Experiments with Calcic Sulphate.

15. Supposing that the substance giving the citron band formed a sulphate more soluble in water than calcic sulphate, it was anticipated that repeated washings with cold water would extract some of it, which might then be detected more easily. About four pounds' weight of commercial plaster of Paris, which showed very faint traces of the citron band, were mixed with water and rapidly poured on a large filter. Before the mass solidified a slight saucer-like depression was made in the upper part, and a few ounces of water were poured on. This ran through slowly, and it was then poured back and the exhaustion repeated several times. The aqueous extract was then evaporated to dryness, ignited with sulphuric acid, ground in a mortar with small successive quantities of water, the liquid boiled, filtered, and precipitated first with ammonia, and the filtrate with ammonic oxalate. These precipitates both showed the citron band very fairly, far more intensely than it was seen in the original calcic sulphate. The green and red bands were also visible.

The same mass of plaster of Paris was then washed, as before, with a little dilute hydrochloric acid passed through several times, and this extract was treated in the same way by evaporation and extraction with water, and the filtrate precipitated, first with ammonia, and then with ammonic oxalate. In these precipitates the citron band, together with the green and red bands, were much more brightly manifest than in the precipitates from the aqueous extract.

Wide Distribution of the Citron Band-forming Body.

16. These experiments are conclusive in proving that the citron band is not due to calcium, but to some other element, probably one of the earthy metals, occurring in very minute quantities, but widely distributed along with calcium, and I at once commenced experiments to find a more abundant supply of the body sought for. Amongst other substances tested I may note the following as giving a more or less decided citron band in the spectrum when treated with sulphuric acid in the manner indicated above (10):—Crystallised barytic chlorate, heavy spar, common limestone, strontic nitrate, native strontic carbonate, crystallised uranic nitrate, commercial magnesic sulphate, commercial potassic sulphate, Wagnerite (magnesic phosphate and fluoride), zircon, cerite, and commercial ceric oxalate.

Examination of Zircon for the Citron Band.

17. Some specimens of zircon treated in the above manner appeared sufficiently rich to make it probable that here might be found an available source of the citron band-yielding body. I found it in crystals from Green River, North Carolina, from Ceylon, from Expailly, from Miask (Oural), and from Brevig, and having a good supply of North Carolina zircons I started working up these in the following manner:—

The finely-powdered zircons were fused with sodic fluoride, and the melted mass powdered, boiled with sulphuric acid, and filtered. The solution was precipitated with excess of ammonia, the precipitate well washed and dissolved in hydrochloric acid, and the solution made nearly neutral. A little zirconic oxychloride sometimes separated on evaporation; this was filtered off. An excess of sodic thiosulphate was now added, and the whole boiled for some time until a portion of the filtrate gave no further precipitate on boiling again with sodic thiosulphate. The precipitated zirconic thiosulphate was worked up for zirconia; it was found to be quite free from the substance giving the citron band. The solution filtered from the zirconic thiosulphate was precipitated with ammonia, and the brown gelatinous precipitate was well washed. The filtrate was precipitated with ammonic oxalate, which brought down much calcic oxalate. This showed the citron band, but not strongly. The brown gelatinous precipitate was dissolved in nitric acid. Argentic nitrate was added to separate chlorine, and the filtrate from the argentic chloride was boiled down with nitric acid and excess of metallic tin to separate phosphoric acid. The clear solution, separated from the stannic oxide, phosphate, &c., was boiled down with hydrochloric acid to remove nitric acid, and then saturated with hydric sulphide to separate silver and tin.

18. The filtrate from the sulphides was freed from hydric sulphide by boiling, and was then mixed with tartaric acid and excess of ammonia, to precipitate any yttria that might be present, together with Forbes's zirconia β* (jargonia ?). On standing for some hours this gave a small quantity of a precipitate, which was separated by filtration; it was tested in the radiant matter tube, and found not to give the citron-band spectrum (44). To the filtrate ammonic sulphide was added to precipitate the iron. The black precipitate was filtered off, and the filtrate evaporated to dryness, and ignited to destroy the organic matter. The residue, heated with sulphuric acid and ignited, gave the citron spectrum very brightly. This would probably be the earth which Forbes calls zirconia γ.†

19. For many years chemists have suspected that what is known as zirconia might be a compound. Svanberg‡ found that zircons from different localities varied in specific gravity, and the earth or earths obtained by fractional precipitation with oxalic acid had not the same properties, the hydrogen equivalents of the metals of the earths of the different fractions varying from 17·01 to 27·3, the metal of the earth hitherto recognised as zirconia being 22·4.‖ He considered zirconia to contain two different earths, the oxalate of one being less soluble in acid than that of the other, and their sulphates differing in crystalline form and solubility. He proposed the name "noria" for one of the earths, retaining that of zirconia for the other. The researches of Berlin, on the other hand, seem to disprove this.

20. Remembering the remarkable result produced in the absorption spectrum of some jargons by the presence of a minute trace of uranium,§ I tried numerous experiments with this metal, adding small quantities of it to zirconia, lime, thoria, ceria, &c., but in no case could I educe the citron-band spectrum by this means.

I may condense a year's work on zircon—more than ten pounds weight of crystals from North Carolina having been worked up—by stating that the result was comprised in about 300 grains of an earthy residue (18), and about

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.

* CHEMICAL NEWS, vol. xix., p. 277.
† *Loc. cit.*
‡ *Poggend. Annal.*, vol. 65, p. 317.
‖ Svanberg's numbers for these earths are 938 to 1320 (M_2O_3), the earth hitherto recognised as zirconia being 1140; oxygen being 100. For the sake of uniformity I have recalculated his equivalents for the metals on the O = 16 scale, taking the formula as M_2O (see note 1, par. 40).
§ CHEMICAL NEWS, vol. xix., pp. 121, 142, 205, 277 vol. xx., pp. 7, 104; vol xxi., p. 73.

two ounces of oxalate, chiefly calcium; the former gave the citron band very well. The process as detailed above is given, since by this means a very large quantity of zircons was worked up, affording me the material which ultimately enabled me to solve the problem which at one time seemed almost hopeless.

The zirconia prepared from these zircons when tested sometimes showed the citron band, especially after precipitation as an oxychloride. Zirconia precipitated as thiosulphate did not yield the citron band (28). A zirconia rich in citron band, fractionally precipitated by ammonia, yielded precipitates of increasing richness, the last fraction showing the citron band strongly.

21. The calcic oxalate obtained from zircon gave unsatisfactory results, so attention was directed to the earthy residue (18). This was found to be of highly complex character, containing thoria (which had escaped precipitation as thiosulphate), ceria, lanthana, didymia, yttria, and probably some of the newly-discovered rarer earths.

Examination of Cerite for the Citron Band.

22. The position of the citron band in the spectrum falls exactly on the strongest absorption band of didymium, so that a piece of didymium glass or cell of solution of the nitrate entirely obliterates the citron band. This naturally suggested that the band was due to didymium.

Cerite was accordingly the next mineral experimented on. The powdered mineral tested in the tube in the original way gave a good citron band. It was made into a paste with sulphuric acid, and after all action had ceased it was extracted with cold water. The earths were then precipitated with ammonic oxalate, and the oxalate ignited. The fawn-coloured powder was then converted into sulphate, dissolved in water, and the cerium metals precipitated by long digestion with excess of potassic sulphate. When no didymium bands could be detected in a considerable thickness of the supernatant liquor it was assumed that all the cerium metals were down, and the liquid was filtered.

23. The precipitated double sulphates were dissolved in hydrochloric acid, and the earths precipitated as oxalates. After ignition and treatment with sulphuric acid, the mixed ceria, lanthana, and didymia were tested in the radiant matter tube, but the merest trace only of citron band was visible.

24. This experiment proved the inadequacy of the didymium explanation (22), and further tests showed that not only could I get no citron band in pure didymium compounds, but the spectrum entirely failed to detect didymium in many solutions of the earth which gave the citron band brilliantly.

25. Attention was now turned to the solution filtered from the insoluble double sulphates from cerite (22). Potash in excess was added to the filtrate, and the flocculent precipitate filtered off, and after well washing was converted into sulphate, and tested in a radiant matter tube. The spectrum, of extraordinary brilliancy, was far brighter than any I had hitherto obtained. Unfortunately, however, the quantity was too small to be subjected to very searching chemical analysis.

Examination of Thorite and Orangite.

26. Search was next made amongst other minerals rich in the rarer earths. Thorite, another disputed mineral, was finely powdered, treated with sulphuric acid, and tested in the radiant matter tube. It gave the citron spectrum most brilliantly—equal, in fact, to the mixture of earths obtained from zircons (18, 21) at so great an expenditure of time and trouble. Orangite treated in the same manner gave almost as good a spectrum. Pure thorinic sulphate prepared by myself was found not to give the citron band, but three specimens prepared and given to me by friends all gave it, so it was not unlikely that in thorite and orangite might at last be found a good source of the long-sought element—that in fact the body I was hunting for, if not thorina, might possibly be Bahr's hypothetical wasium. Having obtained about 2 lbs. of orangite and thorite, they were worked up as follows:—

27. The finely-powdered mineral was heated for some time with strong hydrochloric acid, and when fully gelatinised and all action had ceased, it was evaporated to dryness to render the silica insoluble; then extracted with water slightly acidulated with hydrochloric acid, boiled, and filtered. Hydric sulphide was passed through the filtrate for some time. The flask then corked was set aside for twenty-four hours and filtered. The filtrate was evaporated to a small bulk, nearly neutralised with ammonia, and then boiled for some time with excess of sodic thiosulphate. This precipitated the thorina, alnmina, zirconia, and titanic acid, whilst it left in solution the metals of the cerium and yttrium groups. The filtrate was boiled down to a small bulk, when a further precipitation took place: this was filtered off and added to the first thiosulphate precipitate. To the clear filtrate excess of ammonic oxalate was added, and the whole allowed to rest twenty-four hours. The precipitated oxalates were filtered, washed, ignited, dissolved in hydrochloric acid, and the excess of acid evaporated off. The aqueous solution was then mixed with a large excess of freshly precipitated baric carbonate, and set aside for twenty-four hours with frequent shaking (29). This would precipitate much of the cerium, and any iron or alumina which might have escaped previous treatment. The liquid was filtered from the precipitate produced by baric carbonate, and the clear solution, which would contain nothing but barium, and some of the yttrium and cerium metals, was treated as described further on (30).

28. The thiosulphate precipitate tested in the radiant matter tube gave no citron band, nor did it seem possible to detect this band on testing the purified thorina obtained from this precipitate, nor from the alumina or zirconia from the same precipitate. This confirmed the results obtained when working up zircons, that sodic thiosulphate did not precipitate the citron band-forming body.

29. The barium precipitate (27) was dissolved in hydrochloric acid, the baryta separated with sulphuric acid, and the solution precipitated with ammonic oxalate. The ignited precipitate, which amounted to 0·223 per cent of the mineral taken, contained the cerium metals. On testing in a radiant matter tube it gave the citron band only moderately well—not nearly so strong as the original thorite and orangite. The iron and alumina in the filtrate from the ceric oxalates were likewise precipitated and tested; they showed a faint trace of citron band.

30. The solution (27) filtered from the barium precipitate was freed from baryta by sulphuric acid, precipitated with ammonic oxalate, and the precipitate washed and ignited; it amounted to only 0·125 of the mineral taken. Tested in the radiant matter tube it showed the citron band about as well as the corresponding earth from the barium precipitate.

This was disheartening, for after having started with a mineral which gave the citron band well, and having hunted the citron band as it were into a corner, the only result was two trifling precipitates showing the citron band less intensely than did the raw material itself. The experiment, however, proved one thing: the band-forming substance was not thorina. The occurrence of this spectrum must therefore be due to some other element present in small quantity in thorite and orangite.

31. The two mixtures of earths—the one from the barium precipitate (29) and the other from the barium filtrate (30)—which showed the citron line moderately well, were dissolved in sulphuric acid, the solution neutralised as nearly as possible with potash, and digested for several days with excess of potassic sulphate. The solution, which at first showed the didymium bands, was then found to be free from didymium.

32. The insoluble double sulphates were filtered and washed with a cold saturated solution of potassic sulphate. The precipitate was boiled for some time in ammonia, filtered, dissolved in hydrochloric acid, and precipitated

with ammonic oxalate. This precipitate was ignited and tested in the radiant matter tube. It gave scarcely a trace of citron band (23). The earth was further purified by the potash and chlorine method, and was found to consist principally of ceric oxide.

33. The solution filtered from the insoluble potassio-ceric sulphate (31) was boiled with ammonia and ammonic sulphide. A small quantity of a white flocculent earth came down—too small a quantity to weigh. Tested in a radiant matter tube, it gave the citron band better than either of the above precipitates, showing that by this treatment the body had been concentrated (25).

34. It seemed possible that the earth sought for might be present in larger quantity in the thorite, but that it had been gradually carried down mechanically or by mass-action rather than chemically, by the numerous operations it had undergone before getting it to the final stage. Therefore a fresh quantity of thorite was extracted with hydrochloric acid. The solution was precipitated with potassic sulphate, taking the usual precautions to secure complete precipitation. A bulky precipitate ensued, which contained the thorina and cerium earths. These were separated and tested, and found to give only a faint citron band.

35. The solution of earthy sulphates soluble in potassic sulphate was precipitated with ammonic oxalate. The precipitate ignited with sulphuric acid, and tested in a radiant matter tube, gave the citron spectrum with great brilliancy (25, 33).

(To be continued.)

ON THE

ELECTRO-CHEMICAL EQUIVALENT OF SILVER, AND ON THE ABSOLUTE ELECTROMOTIVE FORCE OF CLARK CELLS.*

By LORD RAYLEIGH, D.C.L., F.R.S.

THE investigations upon this subject which have been carried on by Mrs. Sidgwick und myself during the last year and a half, though not yet quite finished, are so far advanced that no doubt remains as to the general character of the results; and as these results have application in the daily work of practical electricians, it is thought desirable to communicate them without further delay.

The currents are measured by balancing the attraction and repulsion of coaxal coils against known weights, as described before the British Association in 1882, a method which has fully answered the favourable expectations then expressed. To what was said on that occasion it will be sufficient for the present to add that the readings were taken by *reversal* of the current in the fixed coils, and the difference of weights thus found (about 1 grm.) represents the double force of attraction, free from errors depending upon the connections of the suspended coil and other sources of disturbance.

The difficulties which have been experienced, and which have been the cause of so much delay, have related entirely to the behaviour of the silver voltameters, of which never less than two, and sometimes as many as five, have been included in the circuit of the measured current. In order to render the deposit more compact, and thus to diminish the danger of loss in the subsequent manipulations, *acetate* of silver was added in the earlier experiments to the standard solution of nitrate. Experience, however, has shown that the principal risk is not in the loss of metal, but in the obstinate retention of salt within the fine pores of the deposit, leading to an over-estimate of the amount. When the texture is very compact this danger increases, and deposits from a solution containing acetate are often decidedly too heavy, even after the most careful and protracted washings. On heating to low redness a portion, at any rate, of the retained salt is decomposed, NO_3 is driven off, and a loss of weight ensues. With pure nitrate, to which we finally recurred, the risk is much less.

The actual weights of deposited silver were usually from 2 to 3 grms., and, so far as the mere weighings are concerned, should have been correct to $\frac{1}{10000}$. Discrepancies three or four times as great as this are, however, actually met with, whether due to retention of salt or to loss of metal it is difficult to say. The final number, expressing in C.G.S. measure the electro-chemical equivalent of silver, is a little lower than that ($1 \cdot 119 \times 10^{-2}$) given on a previous occasion (*Cambridge Proceedings* for November 26, 1883). It approximates closely to $1 \cdot 118 \times 10^{-2}$, and is thus in precise agreeme t with this number announced within the last few weeks by Kohlrausch, viz., $1 \cdot 1183 \times 10^{-2}$. Its substantial correctness can therefore hardly be doubted, more especially as it does not differ very much from the number (1·124) obtained by Mascart. In terms of practical units, we may say that the ampère current deposits per hour 4·025 grms. of silver.

When we are provided with means for the absolute measurement of currents, the determination of electromotive force is a very simple matter if we assume a knowledge of absolute resistance. A galvanic cell is balanced against the known difference of potentials generated by a known current in traversing a known resistance. The difficulty relates entirely to the preparation and definition of the standard cells. A considerable number of Clark cells have been set up and tested at intervals during the last six months, and their behaviour has been satisfactory, the extreme range (after the first ten days) not much exceeding $\frac{1}{1000}$. A modified form of cell in which the solid zinc is replaced by an amalgam is at present under trial.

In Mr. Latimer Clark's own determination the B.A. unit is assumed to be correct, and the E.M.F. of the cell at 15° C. was found to be 1·457 volt. *On the same assumption*, we obtain the not greatly differing value 1·453 volt. If we take the true value of the B.A. unit as 0·9867 ohm., 1·453 will be replaced by 1·434.

Experiments are also in progress to determine in absolute measure the rotation of the plane of polarisation of light in bisulphide of carbon under the action of magnetic force. Of the results obtained by Gordon and Becquerel, differing by about 9 per cent, our preliminary measurements tend rather to confirm the former.

* A Paper read before the Royal Society, March 27th, 1884.

REMARKS ON THE ATOMIC WEIGHT OF BERYLLIUM.*

By W. N. HARTLEY, F.R.S.E., &c., Professor of Chemistry, Royal College of Science, Dublin.

IN a reply to a note by Professor Emerson Reynolds "On the Atomic Weight of Glucinum or Beryllium," presented to the Royal Society by Dr. Frankland on June 7th, 1883, Dr. Humpidge has made some critical observations concerning evidence which I adduced in favour of the value 9 or 9·2. I did not consider that these remarks called for notice at the time, as they were beside the question immediately under discussion, namely, the experimental determination of the atomic heat of the metal, but from the fact that they have been abstracted for various journals, and that greater prominence has been given to them than was perhaps originally intended by the author, I beg to be allowed to comment upon them, as my opinions have been entirely misrepresented. Dr. Humpidge states in allusion to me:—"This chemist concludes from his experiments that glucinum is a dyad metal, and that its homologues are calcium, strontium, and barium, elements with which it has not the slightest analogy." From this sentence it

* A Paper read before the Royal Society, April 3rd, 1884.

appears probable that Dr. Humpidge was not fully acquainted with the nature of the evidence advanced, which, however, might be excusable, since, though the two papers in which it was contained were read at the meetings of the Chemical Society, that "On Homologous Spectra" on March 15th, and that "On the Spectrum of Beryllium" on April 19th, they were not published in the Journal in time for him to have consulted them.*

The sentence quoted above is precisely my argument. "The spectrum of beryllium exhibits no marked analogy with the calcium, the magnesium, or the aluminium spectra, all of which are members of well-defined homologous series."

There is nothing similar to the boron, the silicon, or carbon spectrum, nor to those of scandium, yttrium, or cerium. "The spectrum of lithium is the one most allied to that of beryllium in the number, the relative positions, and intensity of the lines." The question, however, whether beryllium is a dyad, and the first member of the series magnesium, zinc, cadmium, is complicated, since it would probably present a spectrum of a different character to the succeeding homologues, in accordance with the following equation, which follows from the periodic law and holds good for the chemical properties of compounds:—

$$Li : Mg = Be : Al = B : Si.$$

"The relation of the spectrum of lithium to that of magnesium is obscure, that of boron to silicon less so; consequently we might expect that the relation of the beryllium spectrum to that of aluminium would not be well defined."

It is further remarked by Dr. Humpidge:—"And it seems strange that Professor Hartley should consider some slight spectroscopic resemblance between glucinum and the metals of the alkaline earths to outbalance all the weighty chemical and physical differences between them."

The nature of the evidence derived from the spectroscope is here quite misrepresented; probably because of its novelty it was not well understood.

I have found that the spectra of magnesium, zinc, and cadmium are the result of three series of harmonic vibrations with similar intervals, the fundamental vibrations of which differ only in pitch. I have made some similar observations with regard to copper, silver, and mercury, aluminium, indium, and thallium, calcium, strontium, and barium, though maps of some of these spectra have not yet been published. I believe that in series of elements such as these, which exhibit gradational differences in properties and in the properties of their compounds, and approximately equal numerical differences in their atomic weights, we are dealing with the same kind of matter in different states of condensation, or, in other words, with matter having similarly constituted molecules, the vibrations of which are in the same direction and at similar intervals but with different velocities.

If we attempt to classify beryllium in accordance with the views of Nilson and Patterson, the elements scandium and yttrium, with atomic weights 44 and 89 respectively, must yield spectra characteristic of the series of which aluminium is the first member, but it is not possible to find a place for beryllium in this group, nor in those to which cerium, lanthanum, and didymium belong; it is, in fact, by a process of exclusion first and selection afterwards that the element falls into the dyad series.

In the position which I assign to beryllium, we can account for it being related, through the properties of its compounds, to magnesium and zinc on the one hand, and to aluminium on the other.

If there is one consideration of greater importance than another which should lead to the determination of the position of an element in a series, it is the mode of vibration of the molecule, and of that we have evidence in the spectrum. When the element is one with a low atomic weight there is no difficnlty in interpreting such evidence.

* The latter paper, which appeared first, was published in the June number of the *Journal of the Chemical Society*, which reached me through the post on June 7th; its date of issue was therefore not earlier than the 5th. The paper "On Homologous Spectra" was delayed until September.

ON THE

PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Continued from page 164.)

Situation of the Ferment in the Walls of the Canal.

It has been shown in the case of grape sugar that its converting principle is situated in the deeper parts, and not in the superficial mucous layer of the walls of the alimentary tract. Such is not the case with regard to cane sugar. The superficial surface of the mucous membrane scraped off is quite as efficacious in effecting the transformation of cane sugar as the entire walls. In parallel experiments with cane sugar and grape sugar I have seen that whilst the scrapings of the mucous membrane of the intestine have failed to move grape sugar, cane sugar has been energetically transformed. I have tried the scrapings of the mucous membrane, the parts that were left, and the entire coats against each other, and have not met with results that enable me to formulate any positive difference producible by them.

Action of the Contents of the Stomach upon Cane Sugar.

I have a record of five experiments before me in which cane sugar was kept in contact for twenty and thirty minutes at a temperature of 120° F. with the contents of the stomach of the rabbit taken at a period of digestion. On account of the presence of carbohydrates in the contents themselves, an examination of these placed under parallel circumstances alone required to be made, and the figures deducted from those yielded when cane sugar was employed. An alcoholic extract was made for testing. The results obtained afforded evidence of the occurrence of extensive transformation.

Nature of the Product into which Cane Sugar is Transformed.

The acquirement of a cupric oxide reducing power by a cane sugar product shows that a transformation has taken place, but the question now to be considered is something beyond this—viz., the nature of the body that is produced. For the determination of this point much careful attention has had to be bestowed. I at first thought that the matter stood in a position to be easily disposed of. I had taken the cupric oxide reducing power of the product in a large number of instances before and after treatment with sulphuric acid, and had not observed that the cupric oxide reducing capacity of the product before treatment with sulphuric acid had advanced beyond that of maltose in relation to the reducing power after treatment with sulphuric acid, and was generally less. I therefore thought I was entitled to draw the conclusion that the transformation was into maltose, or into one of the dextrins of less cupric oxide reducing power than maltose, or instead of one of these dextrins that the product consisted of maltose and untransformed cane sugar.

Whilst in this position an instance occurred in which the figures showed that the transformation had advanced to glucose, and subsequently I found that under the influence of a large amount of ferment, or under prolonged action with a less amount, either glucose or something near it in reducing power may be produced. It was in operating with pig's intestine that I first noticed what I have mentioned. The product was exposed to heat one

* A Paper read before the Royal Society, Dec. 20th, 1883.

day and allowed to stand till the following day, when glucose was found to have been produced.

The subjoined may be given as an example illustrative of the production of glucose:—

Experiment.—Scrapings from a considerable length of the cleansed intestine of a rabbit were mixed with water and passed through muslin, so that measured quantities could be taken. Five cub. centims. of a solution of cane sugar, equivalent to 0·096 of glucose, were then mixed respectively with 20 and 40 cub. centims. of the intestinal product, and exposed for two hours to a temperature of 120° F.

Analysis yielded the following results:—

		Cupric oxide reducing power expressed as glucose.
20 c.c. of the intestinal product with 5 c.c. of a solution of cane sugar (=0·096 grm. glucose) exposed for two hours to 120° F.	Before sulph. acid	0·078 grm.
	After ,, ,,	0·092 ,,
40 c.c. of the intestinal product with 5 c.c. of a solution of cane sugar (=0·096 grm. glucose) exposed for two hours to 120° F.	Before sulph. acid	0·096 grm.
	After ,, ,,	0·096 ,,

With the employment of the 20 cub. centims. of intestinal product the transformation, it will be noticed, was not carried as far as glucose. The relation in reducing power before and after sulphuric acid in reality stood as 84 to 100. With the 40 cub. centims., on the other hand, the reducing power before was the same as that after glucose therefore existed.

Looking at the fact that cane sugar had been observed to pass into glucose, the important question now presented itself whether with a product presenting the reducing characters of maltose, or a dextrin, such a product really existed, or whether the difference in the reducing power before and after treatment with sulphuric acid was not due to the existence of glucose with untransformed cane sugar. For instance, suppose after the action of the ferment upon cane sugar the product gave a reducing power of 61 before treatment with sulphuric acid and 100 afterwards, this might be due either to the presence of maltose or to 61 of glucose and untransformed cane sugar equivalent in amount to 39 of glucose. Both suppositions are equally applicable by way of argument, and it is only by appeal to observation of a character to afford assistance that the point as to which view is correct can be settled. It is a property of cane sugar to be as readily convertible into glucose by boiling with citric acid as by boiling with sulphuric acid, whilst such I have found is not the case with maltose, whether derived from starch or constituting a product of transformation of cane sugar. A difference here then exists, and I will proceed to show that this difference of behaviour may be turned to account for affording the information required.

In order that the proposition I have advanced may be seen to be well founded I will, as a preliminary step, give the results derived from the examination of actual mixtures of cane sugar and grape sugar, cane sugar and maltose, and grape sugar and maltose.

Mixture of Cane and Grape Sugars.

Ten cub. centims. of a solution of cane sugar containing cane sugar equivalent to 0·213 grm. of glucose were mixed with 10 cub. centims. of a solution of grape sugar containing 0·207 grm. of glucose. Water was added to bring the volume to 150 cub. centims., which was divided into three equal parts. One part was titrated at once; the second boiled with citric acid (in proportion to give a 2 per cent solution), neutralised, and then titrated; and the third was treated in a similar manner with sulphuric acid. From the cupric oxide reducing power of each the figures for the whole volume of 150 cub. centims. were deduced by calculation. Against the figures actually obtained I will place those which theoretically would be yielded.

	Figures theoretically yielded.	Figures actually obtained.
Before treatment with acid ..	0·207 grm.	0·207 grm.
After boiling five minutes with citric acid	0·420 ,,	0·414 ,,
After boiling 1¼ hours with sulphuric acid	0·420 ,,	0·414 ,,

Maltose and Cane Sugar.

Ten cub. centims. of the solution of cane sugar containing cane sugar equivalent to 0·213 grm. glucose were mixed with 50 cub. centims. of a solution of maltose, prepared by the action of saliva on starch, and having a reducing power equivalent to 0·165 grm. glucose before boiling with sulphuric acid and 0·426 after. Water was added to bring the volume of the mixture up to 150 cub. centims., and this was then divided into three equal parts, and dealt with in the manner represented below with the results that are given.

	Figures theoretically yielded.	Figures actually obtained.
Before treatment with acid ..	0·165 grm.	0·165 grm.
After boiling five minutes with citric acid	0·378 ,,	0·381 ,,
After boiling 1¼ hours with sulphuric acid	0·639 ,,	0·651 ,,

Maltose and Grape Sugar.

Ten cub. centims. of the solution of grape sugar equivalent to 0·201 grm. glucose were mixed with 50 cub. centims. of the solution of maltose, having a reducing power equivalent to 0·165 grm. glucose before boiling with sulphuric acid and 0·426 after, and water added to bring the volume to 150 cub. centims. This was divided into three equal parts, which were dealt with as shown below, the results obtained being mentioned.

	Figures theoretically yielded.	Figures actually obtained.
Before treatment with acid ..	0·372 grm.	0·375 grm.
After boiling five minutes with citric acid	0·375 ,,	0·375 ,,
After boiling 1¼ hours with sulphuric acid	0·633 ,,	0·639 ,,

(To be continued.)

ON A NEW VOLUMETRIC METHOD FOR THE ESTIMATION OF NITROUS ACID.

By A. G. GREEN and S. RIDEAL, F.C.S.

We have found that the formation of diazo-benzene from aniline by the action of nitrous acid takes place quite quantitatively if sufficient time be allowed, and that on this reaction may be based a very accurate method for the estimation of nitrites. The least excess of nitrous acid remaining after the reaction is complete is indicated on adding starch and potassic iodide. The process is most conveniently conducted as follows:—

A decinormal solution of pure aniline is made up containing rather more than twice its equivalent of acid, one half being hydric sulphate and the other hydric chloride. A weighed quantity of the nitrite to be estimated is dissolved in a known volume of water, so that its strength shall be somewhere between deci- and centinormal. The amount of nitrous acid in this solution is then roughly determined by means of centinormal permanganate or by a

preliminary experiment with the decinormal aniline solution. Several experiments are then made, using the same quantity of the aniline solution in each case, but varying the amount of the nitrite solution within the limits of the rough determination. After standing over-night the reaction will be completed. To each is then added an equal volume of a solution of starch and potassic iodide; the one in which there is a faint blue colour will show that a slight excess of nitrous acid has been added. We find that if the decinormal aniline solution be sufficiently diluted (with about four times its volume of water if the nitrate is about decinormal), and the nitrite run in slowly, the addition of ice is unnecessary.

Our experiments have shown that nitrous acid can be estimated in this way to less than 0·1 per cent, as owing to the extreme delicacy of the starch and potassic iodide test a very small excess of nitrous acid is indicated. The excess of nitrous acid does not seem to suffer much decomposition on standing over-night in the acid solution, but for very accurate results it is best to allow the solutions to stand in an atmosphere of carbonic acid or coal-gas.

Our results were confirmed by using a standard solution of sodic nitrite prepared from a weighed amount of pure silver nitrite.

In addition to its greater delicacy, this method can be used in many cases where, owing to the presence of oxidisable substances, the permanganate process is inapplicable.

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OPENING UP ZIRCON.

By F. STOLBA.

FINELY ground zircon is quickly rendered soluble if fused with a mixture of potassium borofluoride and potassium carbonate. The author takes two parts of the former to 3 of the latter, and prepares an intimate, finely divided mixture, which is kept ready for use.

Of this mixture 4 parts are taken to 1 of zircon, thoroughly mixed and melted in a platinum crucible at a red heat. The mass fuses readily, froths at first and gives off bubbles of gas, and flows then quietly, forming a very fluid melt. If the zircon is finely ground, 15 minutes are sufficient for this operation. The loss of weight is 15 per cent, and is not notably increased on prolonged fusion. It corresponds approximately to the weight of the carbonic anhydride present in the potassium carbonate.

As pungent vapours are given off during fusion, the operation should be conducted under a draught-hood. The activity of the mixture in attacking zircon appears from the following experiment:—Two zircon crystals, each weighing ½ grm., were introduced into the melted mixture and subjected to prolonged heat. In a short time they decreased perceptibly in size; each of them broke up into two fragments, and within an hour they were entirely dissolved. The melted mass is poured upon a dry metal plate, and when congealed is thrown into water. It is at once intersected with a number of fissures which facilitate pulverisation. This process is the more necessary as the unbroken mass is very slowly attacked by water even on prolonged boiling. The powder is boiled in a large quantity of water so as to remove everything soluble. There is obtained a faintly alkaline solution and a sediment insoluble in water. From the filtrate alkalies throw down zirconium hydroxide, free from iron.

The portion insoluble in water is readily dissolved in hydrofluoric acid and is converted into zircon-potassium fluoride. The chief bulk of the zirconium is found in the aqueous solution in the state of double fluorides. The platinum crucible is not in the least attacked during melting. On the contrary, dirty platinum crucibles may be advantageously cleaned by melting in them a little of the above-mentioned mixture.

If finely divided zircon is boiled for a long time with caustic lye it is perceptibly attacked. It is very probable that in this manner zircon might be entirely dissolved under a pressure of 10 atmospheres.

Potassium borofluoride may be readily prepared from cryolite. Crucibles of nickel seem especially well adapted for the fusion of zircon in caustic alkalies.—*Ber. Bœhm. Gesell. Wissenschaft.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

TELLURIUM.

PARTICULAR interest attaches to the atomic weight of tellurium, on account of the speculations of Mendelejeff. According to the "periodic law" of that chemist, tellurium should lie between antimony and iodine, having an atomic weight greater than 120, and less than 127. Theoretically, Mendelejeff assigns it a value of Te = 125; but all the published determinations lead to a mean number higher than would be admissible under the aforesaid "periodic law." Whether theory or experiment is at fault remains to be discovered.

The first, and for many years the only, determinations of the constant in question, were made by Berzelius.† By means of nitric acid he oxidised tellurium to the dioxide, and from the increase in weight deduced a value for the metal. He published only his final results; from which, if O = 100, Te = 802 121. The three separate experiments give Te = 801·74, 801·786, and 802·838; whence we can calculate the following percentages of metal in the dioxide:—

80·057
80·036
80·034

Mean 80·042 ± 0·005

The next determinations were made by von Hauer,‡ who resorted to the analysis of the well crystallised double salt $TeBr_4.2KBr$. In this compound the bromine was estimated as silver bromide, the values assumed for Ag and Br being respectively 108·1 and 80. Recalculating, with our newer atomic weights for the above named elements, we get from v. Hauer's analyses, for 100 parts of the salt, the quantities of AgBr which are put in the third column:—

2·000 grms. K_2TeBr_6	gave	69·946	per cent Br.	164·460
6·668	,,	69·8443	,,	164·221
2·934	,,	69·9113	,,	164·379
3·697	,,	70·0163	,,	164·626
1·000	,,	69·901	,,	164·355
			Mean	164·408 ± 0·045

From Berzelius's series we may calculate Te = 128·045, and from v. Hauer's Te = 127·419. Dumas,|| by a method for which he gives absolutely no particulars, found Te = 129.

In 1879, with direct reference to Mendelejeff's speculations, the subject of the atomic weight of tellurium was taken up by Wills.§ The methods of both Berzelius and

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 28, 395. 1833.
‡ *Sitzungsb. Wien. Akad.*, 25, 142.
|| *Ann. d. Chim. et de Phys.*, (3), 55, 129. 1859.
§ *Journ. Chem. Soc.*, Oct., 1879, p. 704.

von Hauer were employed, with various rigid precautions in the way of testing balance and weights, and to ensure purity of material. In the first series of experiments tellurium was oxidised by nitric acid to form TeO_2. The results gave figures ranging from Te=126·31 to 129·34:—

2·21613 grms. Te gave	2·77612 TeO_2.	79·828 per cent Te.
1·45313 ,,	1·81542 ,,	80·044 ,,
2·67093 ,,	3·33838 ,,	80·007 ,,
4·77828 ,,	5·95748 ,,	80·207 ,,
2·65029 ,,	3·31331 ,,	79·989 ,,
	Mean	80·015 ± 0·041

In the second series tellurium was oxidised by aqua regia to TeO_2; with results varying from Te=127·77 to 128·00:—

2·85011 grms. Te gave	3·56158 TeO_2.	80·024 per cent Te.
3·09673 ,,	3·86897 ,,	80·040 ,,
5·09365 ,,	6·36612 ,,	80·012 ,,
3·26604 ,,	4·08064 ,,	80·037 ,,
	Mean	80·028 ± 0·004

Combining these series with that due to Berzelius, we have the following general mean:—

Berzelius..	80·042	± 0·005
Wills, 1st series ..	80·015	0·041
,, 2nd ,, ..	80·028	0·004
General mean ..	80·035	0·003

Hence Te=127·986 ± 0·035.

By von Hauer's process, the analysis of $TeBr_4.2KBr$, Wills's figures give results ranging from Te=126·07 to 127·61. Reduced to a common standard, 100 parts of the salt yield the quantities of AgBr given in the third column:—

1·70673 grms. K_2TeBr_6 gave	2·80499 AgBr.	164·349
1·75225 ,,	2·88072 ,,	164·398
2·06938 ,,	3·40739 ,,	164·657
3·29794 ,,	5·43228 ,,	164·717
2·46545 ,,	4·05742 ,,	164·571
	Mean	164·538 ± 0·048

Combined with von Hauer's mean, 164·408 ± 0·045, this gives a general mean of 164·468 ± 0·033. Hence Te=127·170 ± 0·173.

The two independent values for Te combine thus:—

From TeO_2	Te=127·986	± 0·035
,, TeK_2Br_6	,, 127·170	0·173
General mean ..	,, 127·960	0·034

If O=16, Te=128·254.

A careful consideration of the foregoing figures, and of the experimental methods by which they were obtained, will show that they are not absolutely conclusive with regard to the place of tellurium under the periodic law. The atomic weight of iodine, calculated in a previous chapter, is 126·557. Wills's values for Te, rejecting his first series as relatively unimportant, range from 126·07 to 128·00; that is, some of them fall below the atomic weight of iodine, although none descend quite to the 125 assumed by Mendelejeff.

In considering the experimental methods, reference may properly be made to the controversy regarding the atomic weight of antimony. It will be seen that Dexter, estimating the latter constant by the conversion of the metal into Sb_2O_4, obtained a value approximately of Sb=122. Dumas working with $SbCl_3$ obtained a similar value. Schneider and Cooke, on the other hand, have established an atomic weight for antimony near 120, and Cooke in particular has traced out the constant errors which lurked unsuspected in the work of Dumas and Dexter. Now in some physical respects tellurium and antimony are quite similar. As constant errors vitiated the recently accepted values for Sb, so they may also affect our estimates for Te. The oxidation of Te by nitric acid resembles in minor particulars that of Sb. The analysis of K_2TeBr_6 gives a low value for Te, and yet the material may have contained traces of oxybromides, the presence of which would render even that lower value too high. A careful revision of the atomic weight of tellurium is still necessary.

The following additional note has been communicated by the author:—

According to Brauner (see abstract in *Berichte*, 16, 3055), the atomic weight of tellurium is near 125. His experiments, of which the details are not yet accessible to me, give values ranging from 124·94 to 125·40. Tellurium, then, comes regularly under the periodic law.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, April 7th, 1884.

GEORGE BUSK, Esq., Treasurer and Vice-President, in the Chair.

ROBERT ELLIS DUDGEON, M.D., David John Russell Duncan, and Willoughby Smith were elected Members of the Royal Institution.

Four candidates for membership were proposed for election.

The arrangements for the Lectures after Easter were announced (see page 179).

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Annual Report of the Proceedings of the Sussex Association for the Improvement of Agriculture. Season 1883.

FROM the Report of the chemist to the Association, Professor Jamieson, it would appear that views hitherto generally accepted concerning the action of manures are undergoing some modification. He ascribes injurious effects to the action of acids generally, but especially sulphuric acid. To quote his own words:—"Sulphur was referred to in a special manner because it had not hitherto been supposed to be injurious, but had actually been supposed to be an essential ingredient in the food of plants, and it was also referred to because those manures sold as soluble manures (dissolved bones and superphosphate) were soaked with it. Many other mixtures sold under the names of 'Corn Manure,' &c., contained more or less of this irritant. Amongst all the plant-irritants the one they had to fear most was sulphuric acid."

To this view the author says he has been "unintentionally and unexpectedly" led by his experiments. How fully this conclusion conflicts with the ordinary opinion may be judged from the following quotations:—In "How Crops Grow," by Johnson, Church, and Dyer, we read, as here quoted (p. 159), "Potash, lime, magnesia, phosphoric pentoxide, and sulphuric trioxide, are absolutely necessary for the life of agricultural plants." Mr. Warington in his "Chemistry of the Farm" (p. 3) writes:—"The incombustible ash always contains five chemical elements—potassium, magnesium, calcium, iron, and phosphorus. These five elements, though forming a very small portion of the plant, are indispensable to its life."

The evidence which Mr. Jamieson offers in support of his opinion is experimental. His operations have been carried on at Hassocks Station, a locality, according to his description, exceedingly suitable. The whole plot enjoys a uniform natural drainage. The whole of the surface soil was removed and the experiments were conducted in the sandy subsoil, which is practically pure and hence barren, being entirely dependent for plant food on the manures supplied. Being, as Mr. Jamieson tells us, "destitute of the varying quantities of corrective black matter contained in ordinary soils it is fitted to show with precision the good or evil effects of ingredients in manures."

One of the author's first objects seems to have been to ascertain whether soluble phosphates have really the decided advantage of insoluble ones—calcium tri- and di-phosphates—that is commonly ascribed to them. He found—and it must be remembered that certain agricultural chemists in Germany are coming to the same conclusion—that the efficacy of insoluble mineral phosphate is only slightly below that of soluble mineral phosphate. Hence the necessity for treating the coprolites, &c., with sulphuric acid to render their phosphates soluble becomes doubtful.

But a further result appeared, viz., that sulphuric acid is in itself a dangerous ingredient, tending to produce in root-crops the well-known evil "club-disease." Thus in the year 1880 and 1881, out of 600 plants treated with dissolved bone-ash alone, or along with other fertilisers, the proportion of diseased roots was from 545 to 594. With undissolved coprolite, and with bone-flour, dung, and coprolite, the numbers of diseased roots out of 600 ranged from 170 to 27! From the same tables we learn another remarkable fact, that if bone-flour was mixed with sulphate of ammonia the proportion of diseased roots out of 600 was, in the two years, 394 and 425. From experiments made in Aberdeenshire the author was led also to conclude that "liberal application of super-phosphate, dissolved bones, sulphate of ammonia, or vitriolised or nitrogenous matters generally, for the turnip crop, would be almost inviting a diseased crop. Upon grain-crops sulphuric acid has a less injurious action. Mr. Jamieson makes the judicious remark that Liebig, when experimentally comparing the relative fertilising power of dissolved and of insoluble phosphates, had not the opportunity of comparing them with precipitated phosphates and with the fine phosphatic flours of the present day.

It will of course be understood that in the sandy soil of Hassocks no substance is present which can mask or modify the properties of sulphuric acid. The author notes, as already shown, that sulphate of ammonia has an injurious action upon root-crops. In discussing the effects of potash on turnips and peas he remarks that "potash salts, whose acids are not required by plants (such as the sulphate and chloride) positively injure or even kill the plants," though soda (set free from nitrate of soda) or a sufficiency of organic matter contained in the soil may prevent this mischief.

Like all previous investigators Mr. Jamieson finds that potash is essential and that its place cannot be supplied by soda.

Concerning the action of nitrogen he comes to the conclusions that urine and guano are hurtful until certain of their ingredients (probably organic acids) are corrected by the soil. Sulphate of ammonia, nitrate of lime, and nitrate of soda give nearly equal results—it would appear with wheat—the difference being always in favour of the nitrate of soda.

The author considers it as practically established that as far as agriculture is concerned neither sulphur, magnesia, nor lime is required in manures; nitrogen, phosphorus, and potash being the only elements required. Nitrogen influences chiefly the grain-crops, phosphorus the root-crops, whilst potassium does not show a marked effect upon one class of plants more than another.

How flatly these results conflict with those of Ville need scarcely be stated. The latter chemist thinks it necessary to add sulphate of lime to manures for every crop, and, apparently, on every kind of soil. How these apparent contradictions are to be reconciled it is not easy to see. Much of the beneficial effect ascribed to lime is due, as is emphasized by Dr. Smith, the State Geologist of Alabama, to its action upon organic matter and mineral compounds present in the soil. As the pure sand of Hassocks contained no such ingredients we may expect that it would be of little avail. We must also weigh the fact that Mr. Jamieson has not experimented upon the fruit-trees of the order *Rosaceæ*, eminently calciphilous.

There is another point which deserves attention. The author infers from his experiments that the "absence of nitrogen is very marked on *all* the crops." Now among these are included not merely grain, grass, and roots, but leguminous crops. Here then we have again a serious discrepancy. Some experimentalists urge that upon plants of this class nitrogenous manures have no influence. They have even been held capable of absorbing and fixing the free nitrogen of the atmosphere. Here, then, is another point on which verbal discussion is useless, and which can be cleared up only by a course of special experiments.

On the subject of soils and their necessary properties Mr. Jamieson makes some very interesting remarks, which point in the direction of reconciling the hitherto conflicting experience and practice of the farmer and of the market-gardener. He distinguishes, as regards soils, two distinct doctrines:—"The common doctrine that the quality of soil depends on the proportion of decaying vegetable matter, a doctrine held by the advocates of vegetable mould, dung, grazing, permanent pasture, and rest; and —what I venture to call the *coming* doctrine—that it depends entirely on the *suitability of the mechanical state of division of the soil particles.*"

In rejecting the former doctrine, Mr. Jamieson approximates to the position of M. Ville. He shows that the coarse soil obtained from ground bricks and the ultra-fine soil produced by cement-clay, however rich in mineral plant food, fail to grow crops until their consistency is rendered suitable. If a suitable consistency is obtained good crops are got in the absence of humus, if there is a due supply of moisture and the needful quantity of mineral plant-food. In the experimental plots at Hassocks, humus was wanting, yet, on the needful mineral matters being furnished—see Ville on "Artificial Manures," 2nd English edition, pp. 19, 49, 50—good crops were obtained.

But Mr. Jamieson takes a further and not unimportant step. He explains why vegetable mould has come to be regarded by practical men as necessary to fertility. The introduction of organic matter is *one method*, and perhaps the easiest and most obvious of *attaining suitable consistency.* "While organic matter is not essential we must recognise in dung, vegetable mould, and organic matter generally, a valuable adjunct in the cultivation of most soils. This suitability for most soils probably explains the general misapprehension of its real function."

The so-called "loam" of the florists, consisting of the upper layer of an old pasture laid in heaps until the roots of the grasses in it are decayed, is the type of suitable consistency, and in practice it matters little whether such "loam" has been obtained from a sandy, or calcareous, or peaty, or a clay soil.

Mr. Jamieson sums up his conclusions on soils in the following propositions:—"That the proper function of soil is to provide a large quantity of moisture for plants and a very small quantity of mineral matter. That the soil may be called upon occasionally to perform other functions, but that these are subordinate or accidental. That what mainly constitutes good soil is such consistency as will maintain the necessary degree of moisture. This implies freedom from draught and from stagnation also, firmness sufficient for support, but not so great as to present undue resistance to rootlet extension. That certain mineral matters are essential, but the quantities required are comparatively minute. That organic matter is not essential,

though it may often do useful work by assisting to obtain the suitable consistency state and by correcting injurious matter."

Mr. Jamieson is not in favour of permanent pasture—the agriculture of barbarism. He shows that it in reality means "permanent weeds."

Whilst we are not prepared, pending further evidence, to accept the whole of Mr. Jamieson's conclusions, we must admit that his results are exceedingly important and merit careful experimental scrutiny.

Chemical Tables for Elementary Students adapted to the New Syllabus of the Science and Art Department. By W. JOEL KEMP, F.C.S. London: Simpkin, Marshall, and Co.

THIS little work is essentially examinational. To us it is painful to see able, accomplished chemists instead of teaching the science compelled to aim solely at enabling their pupils to pass, and to vary their methods of instruction, not in accordance with their own experience, but to meet the fluctuating demands of a "department." It appears that the new "Syllabus" requires candidates to test two solutions each containing only one of the following metals—silver, lead, mercury, copper, iron, calcium, zinc, magnesium, and potassium, and one only of the following acids—carbonic, nitric, sulphuric, and hydrochloric. Hence the examination of solid substances is excluded. We do not see that the tests recommended or the order of their application varies from those generally adopted in systematic qualitative analysis. Great stress is laid upon nomenclature. The author remarks at the conclusion of his preface:—"As the tendency now is to look upon acids as hydrogen salts, and especially as the Science and Art Department pointedly adopt that view in the Syllabus of the advanced stage, I have ventured to use the terms hydrogen chloride, hydrogen sulphate, &c." We suspect that the risk would have been in adhering to the better known and more convenient terminology.

We cannot censure either the work before us or its author, but we must be permitted to regret the circumstances which render the production of such treatises a matter of necessity.

Experimental Chemistry for Junior Students. By J. EMERSON REYNOLDS, M.D., F.R.S., Vice-president of the Chemical Society, Professor of Chemistry in the University of Dublin. Part III. Metals and Allied Bodies. London: Longmans, Green, and Co.

THIS is a manual of which we can conscientiously speak with decided approval. The author makes no reference to any kind of examinations and of what may be needed in order to pass them. His declared aim is "to place the student to some extent in the position of an independent investigator of chemical phenomena." This, we need scarcely say, has been the object of all really great teachers of chemistry, such as Liebig and Hofmann, and by no other method can a genuine, living knowledge of the science be imparted.

We note also the following remark:—"The ready-made tables often given for the separation or the metals, though generally good, possess little educational value, and their use often produces unintelligent analysts; whereas the gradual development of such schemes by *the student for himself* is a most useful intellectual exercise."

The passages we have just quoted fully prove that Dr. Reynolds is an opponent of cram, with which, indeed, his method of teaching is simply incompatible. The crammed student, as it has been aptly said, is merely like a Faure's accumulator. He receives what has been passed into him and reproduces it again, with a certain amount of loss. Now Dr. Reynolds evidently seeks to make his students able to reproduce what they have learned, with a certain amount of gain.

The first chapters of this book treat of arsenic, antimony, bismuth, vanadium, tantalum, and niobium, tin, titanium, thorium, and zirconium. In short, simple bodies whose claim to rank as metals is not indisputable, and which, if the division of the elements into metals and non-metals has any scientific value, might form a debateable land on the frontiers.

We are glad to find that the rarer metals are not left out in the cold. Their omission in ordinary manuals may lead the student into serious mistakes both in qualitative and quantitative operation. We notice one passage which may possibly be misunderstood. The author writes:—"Clays suitable for this purpose—*i.e.*, brick-making—should not effervesce much when moistened with hydrochloric acid, indicating the presence of but a small proportion of chalk or lime-stone." This sentence would, we submit, be more intelligible if it ran "Clays suitable for this purpose should effervesce but little when moistened &c."

We find here a notice of the excellent alum clay of Glenarm, in county Antrim, which is now rapidly superseding the French bauxite as a material in the alum-manufacture, owing to its comparative freedom from iron. Whilst the French mineral contains 2·7 per cent of this very undesirable impurity, the Irish bauxite, or alum clay, contains only 0·5. Indeed it will be found that though this treatise is necessarily restricted in bulk there are numerous and accurate references to the industrial applications of the bodies described.

Annual Report of the Board of Regents of the Smithsonian Institution: Showing the Operations, Expenditures, and Condition of the Institution for the Year 1881. Washington: Government Printing Office, 1883.

TURNING naturally to the "Report of the Chemist," we find that after examining a part of the collection of minerals then stored in the Smithsonian building, he has been engaged with the inauguration of the new laboratory, which is described in full and shown in plan. The balances are all made by Becker and Son, with the exception of a Jolly's balance for the determination of specific gravities. The assay-room—an important department—where so many ores, &c., have to be examined, is fitted with a Hibb's furnace, with a 4 by 10 inch muffle, a Battersea muffle furnace, with a muffle 6 inches by 14, a crucible furnace and a large sand-bath. There is to be further supplied a small Blake's crusher and a grinding-machine. It is considered that the laboratory is fairly fitted for two chemists, though the supply of platinum ware is considered insufficient. The ventilation is, however, regarded as imperfect; the evaporation-niche too small and its flue not large enough to effect a proper exhaustion.

It is asserted that when the collections of the National Museum have been identified and arranged, it will be found to possess the largest and most complete collection of the minerals, ores, and rocks, not merely of America, but of the world, ever brought together in any one museum.

Among the ores received for assay we find mention of a specimen of arsenical pyrites completely filled with small nuggets of gold, from the size of a pin point to that of an ordinary pin head. They were, indeed, alloyed with a little silver, but the assay showed a value of nearly 30,000 dollars per ton. "Tin ore has been received, though unfortunately the specimens contained no tin; one interesting specimen of this kind presented to the chemist with the assurance that it contained 8 per cent of tin consisted of a mass of small crystals of tourmaline."

The report on the progress of chemistry, by Professor G. F. Barker, of the University of Philadelphia, though an ably-compiled summary, has now merely a historical interest, since it refers merely to the year 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 9, March 3, 1884.

Researches on Detonating Gaseous Mixtures.—MM. Berthelot and Vieille.—This memoir does not admit of useful abstraction.

New Experiments on the Imitation of Electro-chemical Rings by Continuous Currents of Water.—C. Decharme.—The author has made use of a continuous current of water, issuing from a cylindrical or convergent tube (2 to 5 m.m. in diameter), and falling perpendicularly upon a horizontal plate of black glass, moistened over its entire surface. The delivering-tube is fixed at a variable height, but always such that at the distance where the stream encounters the plate it may present no breach of continuity,—an essential condition. It falls then without noise, and produces around the point of impact liquid rings, perfectly fixed. These concentric rings, the diameter and the number of which vary according to the conditions of the experiment, imitate the electro-chemical rings better than the figures produced by the fall of columns of water.

Barium Oxychloride.—G. André.—The author has obtained this compound in a definite state, not mixed either with an excess of base or of chloride. He takes 200 grms. barium chloride, dissolves at a boil in 500 grms. water, withdraws the flask from the fire, and incorporates with the liquid 30 grms. of caustic baryta well pulverised, heats again for five minutes without boiling, and filters. The oxychloride, $BaCl,BaO5HO$, crystallises in a few hours in nacreous laminæ.

New Group of Nitrogenous Compounds.—R. Engel.—The author has obtained a third isomer of lactamide. It is not crystalline: if heated to 200° it does not distil like lactamide, but is decomposed. In presence of water it yields immediately ammonium lactate. Thus its ammonia may be entirely precipitated in the cold by platinum chloride, which is not the case with normal lactamide.

The Oxidation of Menthol by means of Potassium Permanganate.—G. Arth.—The author has obtained by this reaction two distinct acids. The second of these seems to be an intermediate product between the former, $C_{10}H_{18}O_3$, and the carbonic and oxalic acids.

Two Camphol-urethanes of an Isomerism analogous to those presented by Dextro- and Lævo-Tartaric Acids.—M. Haller.—The crystals yielded by dextro-camphol are hemihedral to the right, and their solution deflects the plane of polarisation to the right. The crystals derived from lævo-camphol are hemihedral to the left, and deflect the plane of polarisation to the left. This dyssymmetry is in all points similar to that presented by the dextro and lævo double ammonium-sodium tartrates.

Die Chemische Industrie.
Vol. vii., No. 2, February, 1884.

Phosphoric Acid, soluble in the Soil.—Dr. A. Stutzer.—The author points out that the use of ammonium citrate was originally proposed by Prof. Fresenius for distinguishing "reverted" phosphoric acid from that portion of phosphoric acid in phosphatic minerals which has never been rendered soluble in water. He complains that this method designed for one special case has been used for phosphoric acid which *is rendered soluble in the soil.* Under this latter term he understands all forms of phosphoric acid combined with lime, iron, alumina, &c., which in consequence of their physical or chemical nature are capable of serving as plant-food. For the determination of such phosphoric acid ammonium citrate is ill-adapted, as it dissolves only very insignificant quantities. As a substitute he proposes a dilute solution of free citric acid. His method is as follows:—5 grms. of the manure passed through a 1-millimetre sieve are placed in a litre flask and let stand in the cold for an hour with ½ litre of a 1 per cent solution of citric acid, with occasional shaking. Moist manures are of course ground up in the mortar. The flask is then filled up to the mark with water and the proportion of phosphoric acid is determined by the molybdenum method in a portion of 50 or 100 c.c. It is not necessary to destroy the citric acid. In precipitated phosphate prepared from iron slags the silica must be previously removed by evaporating 200 c.c. of the citric solution to dryness with the addition of potassium chlorate and hydrochloric acid, heating to 110°, taking up the residue with a little nitric acid, diluting to 200 c.c., and then determining the phosphoric acid in 50 c.c. The author considers that a thorough examination of the capabilities of this method is the more important as it is now very generally admitted that phosphoric acid soluble in water, and such as dissolves only in the soil, are approximately equal in value.

Cosmos les Mondes,
No. 8, February 23, 1884.

Storms and Telegraphs.—In France, telegraphic communication was seriously compromised for 48 hours by the tempest of January 26th. But for the subterranean wires to Lille, Nancy, and the principal towns of the north and east, Paris would have been entirely cut off from the provinces.

The Skrivanow Pocket Battery.—The element is constructed of sheet zinc and silver chloride wrapped in parchment paper, immersed in a solution of 75 parts of caustic potassa in 100 of water. The whole is placed in a small trough of gutta-percha which can be closed hermetically. The conductors and external contacts are of silver. Such an element, when complete, weighs about 100 grms.. Its electromotive force is 1·45 to 1·50 volt, and it yields for an hour a current of 1 ampère.

No. 9, March 1.

Combination-Heat of Soluble Fluorides and the Law of Thermic Substitution Constants.—D. Tommasi.—M. Guntz has quite recently determined the combining-heats of certain fluorides, and the values which he has obtained are identical with those predicted in accordance with his law. As for the combination-heats of barium, strontium, and calcium fluorides, their insolubility prevents the application of the law.

Law of Thermic Constants.—D. Tommasi.—The author gives a table of twenty compounds of magnesium, zinc, copper, and lead, in which the combination-heats, as determined and as predicted according to the above law, are found to agree very closely. M. Tommasi complains of the suppression of this table in his communication sent to the Academy of Sciences.

No. 10, March 8.

This issue does not contain any chemical papers.

Moniteur Scientifique, Quesneville.
March, 1884.

Société Industrielle de Mulhouse: January 9, 1884.—M. Matthieu Plessy sent in a memoir on a tribasic aluminium oxalate. This compound is formed as a white crystalline paste on heating to 150° in a closed vessel tribasic aluminium sulphate in a paste with an excess of a solution of neutral aluminium oxalate. It is also obtained on attacking metallic aluminium with a solution of oxalic acid at 150°.

M. Noelting communicated the continuation of his researches on the xylidines, undertaken in concert with M. Forel. By oxidising symmetrical metaxylidine they obtained metaxylo-quinone, melting at 73°, and by its reduction a metaxylo-hydroquinone fusible at 149°.

M. Casthelaz called the attention of the Committee to a double potassium-antimony oxalate sold as tartar emetic, and containing 23·67 per cent antimony oxide instead of 43·70 per cent.

Solid and Liquid Illuminating Agents.—L. Field.—From the *Journal of the Society of Arts.*

Thickeners, Resists, and Discharges on Printed Calico, as used principally in England.—Robert Bourcart, of Manchester.—Apparently from an English source.

Researches on the Ptomaines and Analogous Compounds.—Dr. Pouchet.—The author obtained certain liquid products, strongly odorous, sparingly soluble in water, very soluble in alcohol, and partially soluble in ether, and consisting of volatile bases mixed with variable substances; and also certain solid products, the quantity of which is very variable, and from which he has obtained two well-defined chloro-platinates. All these compounds are violent poisons, and kill frogs rapidly, occasioning torpor and paralysis, with abolition of reflex movements. The heart stops in systole. Some of the coloured reactions which they produce are absolutely identical with those considered as characteristic of certain vegetable alkaloids, especially aconitine.

Memoir on Printing with Natural Indigo, presented to the Industrial Society of Mulhouse.—Robert Bourcart.—This memoir has appeared in full, with illustrations and specimens, in the *Journal of the Society of Chemical Industry.*

Review of Researches Published Abroad.—G. de Bechi.—A series of abstracts from the *Berichte Deutsch. Chem. Gesell.*, *Liebig's Annalen*, and the *Journ. fur Prakt. Chemie.*

Review of Recent Researches on the Distillation of Coal.—H. Gall.—The papers here inserted are all of English origin.

MISCELLANEOUS.

Notice to Impostors.—We have received numerous letters from scientific men saying that a plausible foreigner, representing himself to be related to some well-known chemist, has succeeded in getting money from them by a more or less distressing tale, which has turned out to be false. We ourselves were similarly victimised a short time ago. It would occupy too much space to print all these communications, so we give this general notice in the hope that the gentleman in question, being satisfied with the good haul he has got out of tender-hearted men of science, will in future devote his persuasive talents to harder-hearted men of the world, who are so much more able to indulge in the luxury of giving.

Royal Institution.—The following are the arrangements for the Lectures after Easter:—

Dr. Klein—Two Lectures on the "Anatomy of Nerve and Muscle," on Tuesdays, April 22 and 29.

Prof. Gamgee—Five Lectures on the "Physiology of Nerve and Muscle," on Tuesdays, May 6 to June 3.

Prof. Dewar—Seven Lectures on "Flame and Oxidation," on Thursdays, April 24 to June 5.

Mr. Hodder M. Westropp—Three Lectures on "Recent Discoveries in Roman Archæology," on Saturdays, April 26 to May 10.

Prof. T. G. Bonney—Four Lectures on the "Bearing of Microscopical Research upon some large Geological Problems," on Saturdays, May 17 to June 7.

The following are the probable arrangements for the Friday Evening Meetings after Easter, 1884, to which Members and their friends only are admitted:—

April 25.—Walter Besant, Esq., "The Art of Fiction."

May 2.—Professor J. W. Judd, F.R.S., Sec. G.S. "Krakatoa."

May 9.—Professor W. Robertson Smith, M.A., LL.D. "Mohammedan Mahdis."

May 16.—Professor W. Odling, M.A., F.R.S., M.R.I. "The Dissolved Oxygen of Water."

May 23.—David Gill, Esq.. LL.D., F.R.S., Her Majesty's Astronomer at the Cape, "Recent Researches on the Distances of the Fixed Stars, and some Future Problems in Sidereal Astronomy.

May 30.—Monsieur E. Mascart, Professeur au Collège de France. "Sur les Couleurs" (in French).

June 6.—Professor Dewar, M.A., F.R.S., M.R.I.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chromium in Iron.—Would any of your subscribers inform me of any method of getting rid of chromium in pig-iron?—Chromium.

Arsenical Mundic.—Can any correspondent tell me the value of arsenical mundic (mispickel) containing 80 per cent of metallic arsenic delivered in Swansea? I have at my disposal a vein of this substance about a mile long and several yards thick, on a mountain side.—Lux.

TO CORRESPONDENTS.

J. Mighall.—A little carbolic acid will prevent the solution decomposing. One per cent will be sufficient.

MEETINGS FOR THE WEEK.

Monday, April 21st.—Medical, 8.30.
— Society of Arts, 8. Adjourned Discussion on Dr. Frankland's Paper on "The Upper Thames as a Source of Water Supply."

Tuesday, 22nd.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.
— Royal Institution, 3. "Nerve and Muscle," by Dr. Klein.

Wednesday, 23rd.—Society of Arts, 8. "Thames Communcations," by J. B. Redman, M.Inst.C.E.
— Geological, 8.

Thursday, 24th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.

Friday, 25th.—Royal Institution, 8. "Art of Fiction," by Mr. W. Besant, at 9.
— Society of Arts, 8. "The Existing Law of Landlord and Tenant in India," by W. G. Pedder.
— Quekett Microscopical Club, 8.

Saturday, 26th.—Royal Institution, 3. "Roman Archæology: the Colosseum," by Mr. H. M. Westropp.
— Physical Society, 3. "On an Indicator Diagram of a Gas Engine," by Profs. W. E. Ayrton and J. Perry. "On a New Speed Indicator," by W. T. Goolden. "On a Speed Indicator," by W. Baily. "On a Metrical Barometer, and on an Immersion Galvanometer," by Dr. W. H. Stone, F.R.C.S.

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J. D. MARWICK, Town Clerk,
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City Chambers,
Glasgow, 11th March, 1884.

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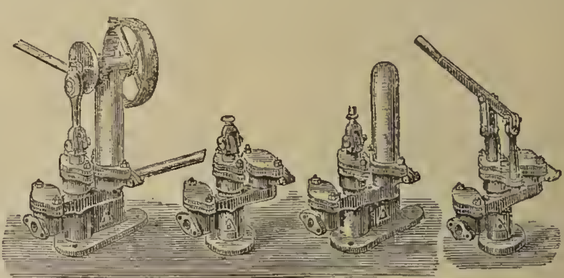

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THE CHEMICAL NEWS.

Vol. XLIX. No. 1274.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Continued from p. 171).

Chemical Facts connected with the Citron Body.

36. Certain chemical facts concerning the behaviour of the sought-for element which came out during the course of the tentative trials already described had considerably narrowed the list amongst which it might probably be found. All the evidence tended to show that it belongs to the group of earthy metals, consisting of aluminium, beryllium, thorium, zirconium, cerium, lanthanum, didymium, and the yttrium family, together with titanium, tantalum, and niobium. The sought-for earth is insoluble in excess of potash (25); this excludes aluminium and beryllium. It is not precipitated by continued boiling with sodic thiosulphate (17, 27); this excludes aluminium, thorium, and zirconium. Fused with acid potassic sulphate, the resulting compound is readily soluble in cold water; this excludes tantalum and niobium. Evaporating to dryness with hydrochloric acid and heating for some time does not render the mass insoluble in water (27); this excludes titanium and silicium. It is easily soluble in an excess of a saturated solution of potassic sulphate (25, 33, 34); this excludes thorium, the cerium group, some of the numerous members of the yttrium group, and zirconium. The only remaining elements among which this elusive body would probably be found are those members of the yttrium family which are not precipitated by potassic sulphate.

37. On the other hand, the body giving the citron band spectrum did not behave like one of the known earths. A rich residue was fused with sodic carbonate, and the mass extracted with water. The insoluble residue, on testing in the usual way, was rich in citron band, but subsequent treatment of the aqueous solution gave me an earth which also gave the citron band strongly.

An acid solution of the citron body was precipitated by ammonia and ammonic chloride. The earth was not completely precipitated, but after a long boiling some remained in solution. I have since ascertained that the detection of the citron-band body in solution under these circumstances is only owing to the marvellous delicacy of the test, which carries our powers of recognition far beyond the resources of ordinary chemistry.

38. Besides obtaining indirect evidence that the citron band was not due to certain elements, I tried special experiments with each substance, brought to the highest possible state of purity. In many cases I detected more or less traces of citron band; but I had come to the conclusion, abundantly warranted by facts, that this citron band was an extraordinarily sensitive test of the presence of the element causing it; and the minute chemistry of many of these earthy metals being insufficiently known, it was not surprising that traces of one of them should adhere to another in spite of repeated attempts to purify it out. With each successive fractional precipitation the citron band became fainter, showing that with perseverance the last trace would probably disappear. The time this process would have occupied, in my opinion, seemed not worth the little additional evidence it would have afforded.

39. Taking into consideration the extremely small quantity of phosphorescent material which had so far been obtained, all these experiments justified me in assuming that the body sought for not only belonged to the group of earths, but also most probably to the sub-group not precipitated by potassic sulphate to which yttria belongs. As, however, the number of these metals has increased so much within the last few years, and as the quantity of material which I had up to the present at my disposal was too small to admit of a satisfactory chemical examination being made of it, search was commenced among other sources known to be rich in these metals. Besides, not only did the majority of the substances I had up till now obtained in anything like quantity indicate the citron band earth to belong to the yttria group (33, 34, 36), but also that either the earth itself showed an absorption band in the spectroscope, or was invariably accompanied by one which did. On the other hand, I had a certain amount of evidence that the earth sought for did not show a band in the spectroscope (24); but remembering the extremely small quantity of very impure substance experimented with, the evidence on this point was not at all conclusive.

The Sought-for body one of the Yttrium Family.

40. The yttria earths form a somewhat numerous family. Fortunately for chemists, a mineral rich in yttria earths —samarskite—has been found in large quantity in Mitchell County, North Carolina, and to this mineral I accordingly now directed my attention.

The annexed list of elements of the yttrium and its allied families, said to occur in samarskite and similar minerals, may be considered complete to the present time. (See next page.)

41. Some of these claimants will certainly not stand the test of further scrutiny. Thus samarium and yttrium β are in all probability identical; and I should scarcely have included philippium, as Roscoe* has conclusively proved that this is a mixture of terbium and yttrium, and my own results (61) confirm those of Roscoe. Moreover, others of these so-called elements will probably turn out to be mixtures of known elements. But in the confessedly very imperfect state of our knowledge of the chemistry of these metals it is not safe for me in this research to assume that any one of them will surely not survive. The complete list as it stands will therefore be taken to contain all hitherto claimed as new, although it is almost certain to include too many.

The Sought-for Body has no Absorption Spectrum.

42. In the second column "Yes" or "No" indicates whether the solutions give an absorption spectrum when examined by transmitted light. Now could I definitely settle whether solutions of the citron-band body gave an absorption spectrum or not, I could at once eliminate a whole class of elements.

This was not difficult to determine. I have already said (22, 24) that spectroscopic examination entirely failed to detect didymium in many solutions of the earth which gave the citron band strongly. This was not always the case. In early days of this research I frequently obtained absorption bands innumerable when the citron-band body was known to be present; but as I became better acquainted with the chemical reactions of the new earth I gradually succeeded in eliminating one after the other those metals yielding absorption spectra. The earth from zircons (18, 21) gave the most satisfactory results in this respect. This, after removing the little didymium present, gave but a trace of an absorption spectrum, which from its general appearance was probably due to erbia. The earth obtained from cerite (25), which gave the citron spectrum with great brilliancy, on the other hand yielded no absorption spectrum; and generally I may say that

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.

* *Journ. Chem. Soc.*, vol. 41, p. 277.

Name.	Absorption Spectrum.	Hydrogen equivalent of Metal.(1) (Type of Oxide M_2O.)
Cerium	No	47·1 (2)
Columbium (3)	Yes	—
Decipium..	Yes	57·0 (4)
Didymium	Yes	48·5 (5)
Didymium β	Yes	47·0 (6)
Erbium	Yes	53·3 (7)
Holmium (8)	Yes	54·0 (9)
Lanthanum	No	46·0 (10)
Mosandrum	No	51·2 (11)
Philippium (12)	No	—
Rogerium (13)	Yes	—
Samarium	Yes	50·0 (14)
Scandium	No	14·7 (15)
Terbium	No	49·5 (16)
Thorium	No	58·4
Thulium	Yes	56·5 (17)
Ytterbium	No	57·9 (18)
Yttrium	No	29·7 (19)
Yttrium α	No	52·2 (20)
Yttrium β	Yes	49·7 (21)
Zirconium	No	22·5

(1) As it is at present doubtful whether the oxides of several of the metals in this table belong to the type M_2O, M_2O_3, or MO, I have, for the sake of uniformity and simplicity, in calculating the values from the composition of their salts, by which these metals are chiefly discriminated, taken the type of oxide to be M_2O.

(2) Bührig, "J. Pr. Chem.," ser. 2, vol. xii., p. 209.

(3) Dr. J. Lawrence Smith in a paper read before the United States National Academy of Sciences in 1879, announced the discovery in Samarskite of two new elements, which he named Columbium and Rogerium ("Nature," vol. xxi., p. 146). I have failed to find any further notice of these elements. This Columbium must not be confounded with the well-known Columbium, sometimes called Tantalum.

(4) Delafontaine, "Comptes Rendus," vol. lxxxvii., p. 632, vol. xciii., p. 63; "Chemical News," vol. xxxviii., p. 223, vol. xliv., p. 67.

(5) Clève, "Bull. Soc. Chim.," ser. 2, vol. xxi., p. 246; Brauner, "Comptes Rendus," vol. xciv., p. 1718; "Chemical News," vol. xlvii., p. 175.

(6) Clève, "Comptes Rendus," vol. xciv., p. 1528; "Chemical News," vol. xlv., p. 273. Brauner, "Comptes Rendus," xciv., p. 1718; "Chemical News," vol. xlvi., p. 16.

(7) Clève, "Comptes Rendus," vol. xci., p. 381; "Chemical News," vol. xlii., p. 199; Lecoq de Boisbaudran, "Comptes Rendus," vol. lxxxix., p. 516; "Chemical News," vol. xl., p. 147.

(8) Called by Soret, the first discoverer, "X." Subsequently Clève discovered the same metal and called it holmium. Soret has now adopted Clève's name. "Comptes Rendus," vol. lxxxix., p. 708, and vol. xci., p. 378; "Chemical News," vol. xl., p. 224, and vol. xlii., p. 199. Lecoq de Boisbaudran, "Comptes Rendus," vol. lxxxix., p. 516; "Chemical News," vol. xl., p. 147.

(9) Clève, "Comptes Rendus," vol. lxxxix., p. 478; "Chemical News," vol. xl., p. 125.

(10) Brauner, "Comptes Rendus," vol. xciv., p. 1718; "Chemical News," vol. xlvi., p. 16.

(11) Lawrence Smith, "Comptes Rendus," vol. lxxxvii., pp. 145, 146, 148. Marignac, *ibid.*, vol. lxxxvii., p. 281. Delafontaine, in October, 1878 (*ibid.*, vol. lxxxvii., p. 600), considers mosandrum a mixture of terbium, yttrium, erbium, didymium, and philippium. Subsequently, however, Lawrence Smith, in November, 1878 (*ibid.*, vol. lxxxvii., p. 831), adduces chemical and other reasons to show that his mosandrum is not a mixture, but a true element. A year later, September 1, 1879 (*ibid.*, vol. lxxxix., p. 480), Lawrence Smith repeats the claim for mosandrum to be classed with the elements.

(12) Delafontaine, "Comptes Rendus," vol. lxxxvii., p. 559; "Chemical News," vol. xxxviii., p. 202; "Journ. Chem. Soc.," vol. xxxvi., p. 116.

(13) *See* Note (3) to columbium, *ante*.

(14) Lecoq de Boisbaudran, "Comptes Rendus," vol. lxxxviii., p. 322, and vol. lxxxix., p. 212; "Chemical News," vol. xxxix., p. 115, and vol. xl., p. 99. Brauner, "Chemical News," vol. xlvii., p. 175; Clève, "Comptes Rendus," vol. xcvii., p. 94; "Chemical News," vol. xlviii., p. 39.

(15) Nilson, "Comptes Rendus," vol. xci., p. 118; "Chemical News," vol. xlii., p. 83. Clève, "Comptes Rendus," vol. lxxxix., p. 419; "Chemical News," vol. xl., p. 159.

(16) Marignac, "Ann. Chim. et Phys.," ser. 5, vol. xiv., p. 247; "Journ. Chem. Soc.," vol. xxxvi., p. 113. Delafontaine, "Ann. Chim. et Phys.," ser. v., vol. xiv., p. 238; "Journ. Chem. Soc.," vol. xxxvi., p. 114.

(17) Clève, "Comptes Rendus," vol. lxxxix., p. 478, and vol. xci., p. 328; "Chemical News," vol. xl., p. 125, and vol. xlii., p. 182. Thalén, "Comptes Rendus," vol. xci., p. 376; "Chemical News," vol. xlii., p. 197.

(18) Marignac, "Comptes Rendus," vol. lxxxvii., p. 578; "Chemical News," vol. xxxviii., p. 213. Nilson, "Comptes Rendus," vol. lxxxviii., p. 642, vol. xci., p. 56; "Chemical News," vol. xlii., p. 61.

whenever I started with a sufficient quantity of an earth giving both citron-band spectrum and absorption spectrum, I could, by appropriate chemical means, always separate it into three portions,—one which gave the citron-band spectrum with great brilliancy, and showed in concentrated solution a very faint absorption spectrum, and frequently none at all; another which gave very little citron-band spectrum, but a good absorption spectrum; and a third intermediate portion—about four-fifths of the whole—which gave both citron-band and absorption spectrum. This portion, by repetition of the treatment, could again be split up in the same way, and the operation repeated as often as the stock of material held out.

43. Having definitely settled the question that the metal giving the citron-band spectrum was not one of those giving an absorption spectrum, the possible elements become materially narrowed to the following list:—Cerium, lanthanum, mosandrum, scandium, terbium, thorium, ytterbium, yttrium, yttrium *α*, and zirconium.

Of these the potassic sulphate reaction (36) excludes cerium, lanthanum, scandium, thorium, yttrium *α*, and zirconium, so there are left only the following:—

Mosandrum,
Terbium,
Ytterbium,
Yttrium.

44. Certain chemical reactions for a long time made me dismiss yttrium from the list of likely bodies. In my analysis of zircons (18), towards the latter part of the process, I used the following process to separate the iron:—The solution, mixed with tartaric acid and excess of ammonia, was allowed to stand for some time. A small quantity of a precipitate gradually formed, which was filtered off, and it was this filtrate, after separating the iron with ammonic sulphide, that yielded the greatest quantity of substance giving the citron band. Now one of the methods of separating yttria from alumina, berylla, thoria, and zirconia is to precipitate it as tartrate in the presence of excess of ammonia, the other earths remaining in solution. Fresenius says:—"The precipitation ensues only after some time, but it is complete."

The precipitate thus obtained with tartaric acid and ammonia should therefore contain all the yttria: *it gave no citron band whatever in the radiant matter tube*; whilst the residue, which should be free from yttria (18), proved for a long time the only source of material wherewith to investigate the chemical properties of the body giving the citron spectrum.

45. Another reason which made me, at this stage of the research, pass over yttria, was that I had already tested this earth in the radiant matter tube. In a paper on "Discontinuous Phosphorescent Spectra in High Vacua," read before the Royal Society, May 19th, 1881,* I said—"Yttria shows a dull greenish light giving a continuous spectrum" (75).

For these reasons I for a long time omitted yttria from my list of possible bodies, and considered that the earth, if not a new one, might turn out to be either mosandra, terbia, or ytterbia.

(To be continued.)

Absorption Spectrum of Water.—J. L. Soret and E. Sarasin.—The authors detect in the orange a very slight and narrow dark band, a little less refrangible than the ray D, about at the fifth part of the interval comprised between D and C, but nearer D, corresponding approximately to the wave-length 600.—*Comptes Rendus*.

(19) Clève, "Comptes Rendus," vol. xcv., p. 1225; "Chemical News," vol. xlvii., p. 4; "Bull. Soc. Chim.," vol. xxxix., p. 120; "Chemical News," vol. xlvii., p. 143.

(20) Marignac, "Comptes Rendus," vol. xc., p. 899; "Chemical News," vol. xli., p. 250.

(21) This is almost certainly identical with Lecoq de Boisbaudran's samarium. See Marignac, "Comptes Rendus," vol. xc., p. 899; "Chemical News," vol. xli., p. 250. Soret, "Comptes Rendus," vol. xci., p. 378; "Chemical News," vol. xlii., p. 199.

* *Proc. Roy. Soc.*, No. 213, 1881.

ON THE
PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Concluded from page 173.)

Thus observation shows that there is no difficulty in distinguishing the carbohydrates in combinations under the conditions required to be unravelled, and now let us see how the results stand when the mode of investigation described is put into practice.

Experiment.—Some cane sugar, scrapings from the intestine of a dog, and about 150 c.c. of water were placed in a wide mouthed bottle and exposed to a temperature of 120° F. 20 c.c. were removed at the subjoined periods, made up to 150 c.c. with water, divided into three parts of 50 c.c. each, and examined—one part by titration at once, and the other two parts after boiling for seven minutes with citric acid (2 per cent strength) and sulphuric acid respectively. The figures give the cupric-oxide reducing power expressed as glucose, calculated for what it would be under the different circumstances in the whole 150 c.c. (to which the 20 c.c. were diluted) of liquid each time subjected to analysis. An analysis of the intestinal product itself that was employed gave no reducing action before or after treatment with sulphuric acid.

At the end of five minutes.

	Cupric oxide reducing power expressed as glucose.
Before treatment with acid	0·036 grm.
After boiling with citric acid	0·087 ,,
After boiling with sulphuric acid ..	0·120 ,,

At the end of ten minutes.

Before treatment with acid	0·042 ,,
After boiling with citric acid	0·096 ,,
After boiling with sulphuric acid ..	0·123 ,,

At the end of fifteen minutes.

Before treatment with acid	0·045 ,,
After boiling with citric acid	0·093 ,,
After boiling with sulphuric acid ..	0·120 ,,

At the end of twenty minutes.

Before treatment with acid	0·060 ,,
After boiling with citric acid	0·093 ,,
After boiling with sulphuric acid ..	0·123 ,,

At the end of thirty minutes.

Before treatment with acid	0·063 ,,
After boiling with nitric acid	0·093 ,,
After boiling with sulphuric acid ..	0·120 ,,

At the end of forty-five minutes.

Before treatment with acid	0·066 ,,
After boiling with citric acid	0·087 ,,
After boiling with sulphuric acid ..	0·123 ,,

Let us now examine these figures. At the end of five minutes the 20 c.c. of liquid taken from the bottle contained a product derived from the transformation of the cane sugar originally present, possessing a cupric oxide reducing power equivalent to 0·036 grm. of glucose. After boiling with citric acid the contents of the 20 c.c. possessed a reducing power equivalent to 0·087 grm. glucose, and after boiling with sulphuric acid 0·120 grm. of glucose. The last figures actually represent glucose, and give the total amount producible from the carbohydrate present in the 20 c.c. of liquid. Now, if the 20 c.c. of liquid removed at the end of five minutes had contained glucose and untransformed cane sugar, as cane sugar is convertible into glucose by boiling with citric acid, the figures would have been raised after boiling with citric acid from 0·036 to 0·120, or to the same as after boiling with sulphuric acid. As a matter of fact they were only raised to 0·087. It is, therefore, absolutely manifest that the carbohydrate corresponding with the difference between 0·036 and 0·120 could not simply represent untransformed cane sugar. But the difference between 0·036 and 0·087 may be read as constituting untransformed cane sugar converted into glucose by boiling with citric acid, and if we deduct this representative of untransformed cane sugar which amounts to 0·061 from the total carbohydrate expressed as glucose, viz., 120, the result will be that a product is left with a reducing power equivalent to 0·036 grm. of glucose before treatment with sulphuric acid and 0·069 after, that is, a dextrin possessing a cupric oxide reducing power standing in the relation of 52 to glucose at 100.

With the other portions that were removed at successive periods the figures show a progressive conversion of the cane sugar originally present. At the end of 45 minutes the 20 c.c. possessed a reducing power before treatment with acid equivalent to 0·066 grm. of glucose, 0·087 after treatment with citric acid, and 0·123 after treatment with sulphuric acid. The difference between 0·066 and 0·087 represents untransformed cane sugar which had become reduced to that which corresponds with 0·020 grm. glucose instead of 0·051 grm., as in the first 20 c.c. removed for analysis. Taking away the untransformed cane sugar, a product is left with a reducing power equivalent to 0·066 grm. of glucose before treatment with sulphuric acid and 0·102 after. These figures stand in the relation of 62 to 100, and practically the product may be regarded as maltose.

If we take away the untransformed cane sugar existing in the twenty c.c. removed at the end of ten minutes, the product left represents the reducing power before and after treatment with sulphuric acid of 60 to 100; at the end of fifteen minutes 62 to 100; at the end of twenty minutes 66 to 100; at the end of thirty minutes 66 to 100; whilst he always stated at the end of forty-five minutes the figures stood as 62 to 100. There is here a slight discordancy existing, but nothing more than may be fairly presumed as falling within the range of liable error in the process of analysis; and, looking at the experiment altogether, it may be considered that the transformation did not advance beyond maltose, and that at the end of the time allowed some untransformed cane sugar still remained.

Experiment.—Some cane sugar solution was placed in a wide-mouthed bottle with some finely-divided intestine of a cat, and about 150 cub. centims. of water, and exposed to a temperature of 120° F. Portions of 20 cub. centims. each were removed at the periods mentioned below, and submitted to analysis, with the following results:—

At the end of five minutes.

	Cupric oxide reducing power expressed as glucose.
Before treatment with acid	0·030 grm.
After boiling with citric acid	0·045 ,,
After boiling with sulphuric acid ..	0·060 ,,

At the end of fifteen minutes.

Before treatment with acid	0·033 ,,
After boiling with citric acid	0·042 ,,
After boiling with sulphuric acid ..	0·060 ,,

At the end of thirty minutes.

Before treatment with acid	0·039 ,,
After boiling with citric acid	0·039 ,,
After boiling with sulphuric acid ..	0·060 ,,

At the end of one hour.

Before treatment with acid	0·039 ,,
After boiling with citric acid	0·039 ,,
After boiling with sulphuric acid ..	0·060 ,,

* A Paper read before the Royal Society, Dec. 20th, 1883.

At the end of two hours.

Before treatment with acid	.. ..	0·039 grm.
After boiling with citric acid	.. ..	0·039 ,,
After boiling with sulphuric acid	..	0·060 ,,

The results belonging to the above experiments may be read in the following way:—

At the end of five minutes the reducing power before treatment with acid was equivalent to 0·030 grm. of glucose, after boiling with citric acid to 0·045, and after boiling with sulphuric acid to 0·060. 0·015 grm. of untransformed cane sugar therefore existed, and this deducted leaves a product with the reducing power equivalent to 0·030 grm. of glucose before boiling with sulphuric acid and 0·045 grm. after. These figures stand in the relation of 66 to 100.

At the end of fifteen minutes the untransformed cane sugar had become reduced to 0·009 grm., and the figures left, after the deduction of this, stand in the relation before and after treatment with sulphuric acid of 64 to 100.

At the end of thirty minutes boiling with citric acid produced no alteration in the product. The figures were the same after as before; no untransformed cane sugar therefore existed. Boiling with sulphuric acid, however, carried the reducing power from the equivalent of 0·039 grm. of glucose to 0·060 grm. The relation of these figures is as 65 to 100.

At the end of one hour and two hours the condition was the same as at the end of half an hour. The ferment present, therefore, in half an hour had done its work, which was to leave no untransformed cane sugar, and to produce a body closely approaching in reducing power maltose, if it did not actually consist of maltose.

Experiment.—In this experiment a large quantity of ferment was purposely used. The ferment consisted of finely divided rabbit's intestine, and this was mixed with some cane sugar solution and about 300 cub. centims. of water and exposed to a temperature of 120° F. 50 cub. centim. portions were taken at the undermentioned periods for examination, and the following results obtained:—

At the end of seven and half minutes.

		Cupric oxide reducing power expressed as glucose.
Before treatment with acid	.. .. ..	0·090 grm.
After boiling with citric acid	.. ..	0·108 ,,
After boiling with sulphuric acid	.. ..	0·186 ,,

At the end of fifteen minutes.

Before treatment with acid	.. .. ..	0·120 ,,
After boiling with citric acid	.. .. ..	0·120 ,,
After boiling with sulphuric acid	.. ..	0·184 ,,

At the end of thirty minutes.

Before treatment with acid	.. .. ..	0·150 ,,
After boiling with citric acid	.. .. ..	0·150 ,,
After boiling with sulphuric acid	.. ..	0·186 ,,

At the end of forty-five minutes.

Before treatment with acid	.. .. ..	0·180 ,,
After boiling with citric acid	.. .. ..	0·186 ,,
After boiling with sulphuric acid	.. ..	0·184 ,,

At the end of one hour.

Before treatment with acid	.. .. ..	0·186 ,,
After boiling with citric acid	.. .. ..	0·186 ,,
After boiling with sulphuric acid	.. ..	0·186 ,,

An illustration is afforded by this experiment of cane sugar being carried into glucose, and the intermediate stages are displayed.

At the end of seven and a half minutes there remained cane sugar equivalent to 0·018 grm. glucose, and the other product had a reducing power below that of maltose, the relation of its reducing power before and after treatment with sulphuric acid being as 53 to 100.

At the end of fifteen minutes there was no untransformed cane sugar, the reducing power being the same before boiling with citric acid as after, and the relation in the reducing power before and after boiling with sulphuric acid was as 64 to 100.

At the end of thirty minutes the reducing power of the product had advanced and stood as 80 before treatment with sulphuric acid to 100 after.

At the end of forty-five minutes there was so little difference between the figures before and after boiling with the acids that practically glucose existed.

At the end of one hour all the figures obtained were absolutely identical, and therefore indicative in literal manner of the presence of glucose.

The Portal Blood after Ingestion of Cane Sugar.

I have shown how cane sugar is moved when brought into contact with portions of the alimentary tract, and the nature of the principle into which it may be moved has been just discussed. Evidence is now required to be given of what physiologically occurs, and this is furnished by an examination of the portal blood.

By looking to the condition of the portal blood after the introduction of cane sugar into the stomach of a fasting animal information is supplied of the state in which the carbohydrate exists immediately subsequent to absorption. The following experiments in unmistakable terms show that it is not as glucose cane sugar enters the circulation. In both experiments the product encountered in the portal system possessed a cupric oxide reducing power below that of maltose.

Experiment.—One ounce (28 grms.) of cane sugar, dissolved in three ounces (85 cub. centims.) of water, was introduced into the stomach of a rabbit which had been last fed twenty-four hours previously. In half an hour's time the animal was killed, the abdomen instantly opened and portal blood collected. 27 grms. were obtained for analysis. The blood was poured into spirit in the usual way and the alcoholic extract evaporated down and treated with sulphate of soda.

The following were the figures yielded:—

		Cupric oxide reducing power expressed as glucose.
Before sulphuric acid	.. ..	0·016 grm.
After ,, ,,	.. ..	0·034 ,,

Relation 47 to 100.

Experiment.—30 grms. of cane sugar dissolved in 60 cub. centims. of water were, through an elastic tube passed down the œsophagus, injected into the stomach of a dog which had been previously subsisting upon a meat diet, twenty minutes afterwards the animal was killed and portal blood immediately obtained for analysis. 30 grms. were taken and treated with spirit. Subjoined are the figures that were yielded:—

		Cupric oxide reducing power expressed as glucose.
Before sulphuric acid	.. ..	0·034 grm.
After ,, ,,	.. ..	0·074 ,,

Relation 45 to 100.

Some of the same blood was subjected to examination for the presence of cane sugar by boiling with citric acid, and it was found that the figures obtained after the boiling with citric acid were the same as those before. No cane sugar therefore existed.

Appointments.—Mr. W. Popplewell Bloxam, F.C.S., of King's College, has been appointed Demonstrator in Chemistry at the Royal Naval College, Greenwich.—The Secretary of State for India in Council has been pleased to appoint Mr. David Hooper, F.C.S., of Birmingham, Analytical Chemist and Quinologist to the Government Cinchona Plantations, Nilgiri, Madras Presidency.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending March 31st, 1884.

By WILLIAM CROOKES, F.R.S.
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, April 6th, 1884.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from March 1st to March 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 182 samples of water, the whole were, without exception, clear, bright, and well filtered.

The water supplied to the metropolis during the past month has differed but little in character from that supplied in February. The mean proportion of organic carbon was somewhat higher; but the maximum amount found in any particular sample fell short of the maximum observed in February.

During the past three months we have examined 546 samples of water drawn from the mains of the seven metropolitan companies taking their supply from the Thames and the Lea. They have all, without exception, been characterised by freedom from turbidity, and by a marked and increasing degree of freedom from colour.

Our own report on the quality of the water supply during the preceding month of February was on the whole favourable; only one sample out of the entire number examined being noticed as containing an excessive amount of organic matter. But in the report made to the Registrar-General on the results of the analyses of the water supplied to the metropolis during, as it is stated, the month of February, but in reality on the results of the analyses of one sample of each company's water all taken on the 1st day of February, it is alleged that the water supplied from the Thames by some of the companies "contained a very large proportion of organic matter," and that in the case of two of these companies the water "was thus considerably polluted." According, however, to the Reporter's own figures, the mean amount of organic matter in the five samples only of Thames-derived water, examined by him during (!) the month, was a little under four-tenths of a grain per gallon, and the maximum found in any one sample a little over five-tenths of a grain—a maximum falling far short of the one-thousandth part of 1 per cent of organic matter in the case even of the worst of two waters, both reported to be *considerably-polluted* by the presence of *a very large proportion* of organic matter.

The maximum of organic carbon and consequently of organic matter recorded in the February report to the Registrar-General, is substantially identical with that recorded by ourselves, and noticed by us as of exceptional occurrence; it being indeed not only the maximum of the month, but the maximum hitherto met with by us during the present year. On the other hand, the mean amount of organic carbon and consequently of organic matter recorded by the Reporter to the Registrar-General, from his examination of seven samples of river-derived water all taken on the 1st day of February, is very nearly double the mean amount recorded by ourselves from our examination of twenty-four samples of the water taken on successive days of the month.

We are, Sir,
Your obedient Servants,
William Crookes,
William Odling,
C. Meymott Tidy.

PROUT'S HYPOTHESIS.

By V. H. VELEY, M.A. (Oxon.), F.I.C.

The hypothesis of Prout concerning the relation of all the atomic weights to some one or more fundamental unit is generally admitted in principle, though the more refined stochiometrical determinations have tended rather to complicate than confirm it. The causes of its recognition are obvious: firstly, it satisfies a mental ideal, according to which all differences are ultimately to be reduced to harmonically related differences of numbers; and secondly, the established correlation of the atomic weights of the elements with their chemical function and physical properties has added an *à posteriori* confirmation of the probability of some such hypothesis.

There has recently appeared a paper by Gerber (*Bull. Soc. Chim.*, xxxix., 562—572) in which it is shown that if the elements are divided into four classes according to their dominant activity, there is for each class a common factor, simple multiples of which include all the known atomic weights. The following table contains the four factors d_1, d_2, d_3, d_4 for mono-, di-, tri-, and tetra-atomic elements respectively:—

		O=15·96.	O=16.
$d_1 = \frac{10}{13}H$	.. ..	0·7673	0·7692
$d_2 = 2H$	.. ..	1·995	2·000
$d_3 = \frac{1}{2}[\frac{5}{16}H]$	.. ..	1·5586	1·5625
$d_4 = \frac{5}{4}H$	.. ..	1·247	1·25

Of these factors d_2, d_3, d_4 are in simple relation to one another, though the relation between d_1 and the others is not so obvious. However, there exists a more simple relation between four factors slightly different from the above, the multiples of which, on comparison, give numbers equally in accordance with those obtained by stochiometry. Between these numbers there is a constant logarithmic difference of 0·1.

$$\left.\begin{array}{l} d_1 = 0·797 \\ [d = 1·0] \\ d_4 = 1·262 \\ d_3 = 1·562 \\ d_2 = d_2 \end{array}\right\} \left.\begin{array}{l} \log. 1·262 - \log. 0·797 = 0·2 \\ \log. 1·562 - \log. 1·262 = 0·1 \\ \log. 2 \quad - \log. 1·562 = 0·1 \end{array}\right\}$$

$$0·1 = \log. 1·259$$

It will be necessary here only to adduce a few examples to trace out the relation between the atomic weights of some of the elements:—

$24\ d_1 = 19$ at. w. of	F		$8·8\ d_1 = 7$	at.w. of	Li
$44·5\ d_1 = 35·5$,,	Cl		$28·8\ d_1 = 23$	,,	Na
$100\ d_1 = 80$,,	Br		$49\ d_1 = 39$	,,	K
$160\ d_1 = 127$,,	I				
$8·8\ d_3 = 14$,,	N		$20\ d_2 = 40$	,,	Ca
$20\ d_3 = 31$,,	P		$44\ d_2 = 88$	,,	Sr
$48\ d_3 = 75$,,	As		$68·5\ d_2 = 137$	,,	Ba

As Gerber has pointed out, in some cases an element can equally be classed *g* in two of the four divisions, for the terms of the progressions $n\,d_4$, $n\,d_3$, and $n\,d_2$ coincide frequently. For example—

$28\ d_2 = 36$	$d_3 = 56$	at. w. *g*	Fe
$59\ d_2 = 93·5$	$d_4 = 118$	,,	Sn
$103·5\ d_2 = 164$	$d_4 = 207$	,,	Pb

Iron is both di- and tri-atomic; tin and lead, di- and tetratomic. If, then, there is a constant logarithmic difference between these elemental factors, the multiples of them will be in harmonic relation not only with one another, but with what we may call the basic number 1·260, the logarithm of which is 0·1.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

VANADIUM.

Roscoe's determination of the atomic weight of vanadium is the only one having any present value. The results obtained by Berzelius† and by Czudnowicz‡ are unquestionably too high; the error being probably due to the presence of phosphoric acid in the vanadic acid employed. This particular impurity, as Roscoe has shown, prevents the complete reduction of V_2O_5 to V_2O_3 by means of hydrogen. All vanadium ores contain small quantities of phosphorus, which can only be detected with ammonium molybdate; a reaction unknown in Berzelius's time. Furthermore, the complete purification of vanadic acid from all traces of phosphoric acid is a matter of great difficulty, and probably never was accomplished until Roscoe undertook his researches.

In his determination of the atomic weight, Roscoe‖ studied two compounds of vanadium; namely, the pentoxide, V_2O_5, and the oxychloride, $VOCl_3$. The pentoxide, absolutely pure, was reduced to V_2O_3 by heating in hydrogen, with the following results:—

7·7397 grms. V_2O_5 gave	6·3827 V_2O_3.	17·533 p. c. loss.
6·5819 ,,	5·4296 ,,	17·507 ,,
5·1895 ,,	4·2819 ,,	17·489 ,,
5·0450 ,,	4·1614 ,,	17·515 ,,
5·5296 grms. V_2O_3, re-oxidised gave	6·5814 V_2O_5.	17·501 p. c. diff.
	Mean	17·509 ± 0·005

Hence $V = 51·264 \pm 0·025$.

Upon the oxychloride, $VOCl_3$, two series of experiments were made, one volumetric, the other gravimetric. In the volumetric series the compound was titrated with solutions containing known weights of silver, which had been purified according to the methods recommended by Stas. Roscoe publishes his weighings, and gives percentages deduced from them; his figures, reduced to a common standard, make the quantities of $VOCl_3$ given in the third column proportional to 100 parts of silver. He was assisted by two analysts:—

	Analyst A.	
2·4322 grms. $VOCl_3$ =	4·5525 grms. Ag.	53·425
4·6840 ,,	8·7505 ,,	53·528
4·2188 ,,	7·8807 ,,	53·533
3·9490 ,,	7·3799 ,,	53·510
0·9243 ,,	1·7267 ,,	53·530
1·4330 ,,	2·6769 ,,	53·532
	Analyst B.	
2·8530 ,,	5·2853 ,,	53·980
2·1252 ,,	3·9535 ,,	53·755
1·4248 ,,	2·6642 ,,	53·479
	Mean	53·586 ± 0·039

The gravimetric series, of course, fixes the ratio between $VOCl_3$ and AgCl. If we put the latter at 100 parts, the proportion of $VOCl_3$ comes out as given in the third column:—

	Analyst A.	
1·8521 grms. $VOCl_3$ gave	4·5932 AgCl.	40·323
0·7013 ,,	1·7303 ,,	40·531
0·7486 ,,	1·8467 ,,	40·537
1·4408 ,,	3·5719 ,,	40·337
0·9453 ,,	2·3399 ,,	40·399
1·6183 ,,	4·0282 ,,	40·174
	Analyst B.	
2·1936 ,,	5·4039 ,,	40·391
2·5054 ,,	6·2118 ,,	50·333
	Mean	40·378 ± 0·028

These two series give us two values for the molecular weight of $VOCl_3$:—

From the volumetric series ..	$VOCl_3$ = 173·096	± 0·126
,, gravimetric ,, ..	,, 173·276	0·141
General mean	,, 173·177	0·094

Hence $V = 51·104 \pm 0·104$.

Combining the two values for V we get the following result:—

From V_2O_5..	V = 51·264	± 0·025
,, $VOCl_3$	,, 51·104	0·104
General mean..	,, 51·256	0·024

Or, if O = 16, V = 51·373.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 22, 14. 1831.
‡ *Poggend. Annal.*, 120, 17. 1863.
‖ *Journ. Chem. Soc.*, 6, pp. 330 and 344. 1868.

AN ANALYSIS OF WATER FROM SALT WELLS, NEAR DUDLEY.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S.,
Demonstrator of Chemistry, Mason College.

Salt Wells is not only of considerable local fame for the medicinal properties of its waters, but is also of interest as being the nearest saline spring in the immediate neighbourhood of Birmingham, and because it issues from the coal measures near to the outcrop of the "Thick Coal," about a mile and a half from the nearest Permian strata, while the better known neighbouring spas of Leamington, Droitwich, and Stoke are in the Trias.

The water issues in a pretty little wooded valley in Salt Wells Wood, about a mile south-east of Round Oak Station, on the Great Western Railway. Part of the water is passed through the heating apparatus and to the baths, while another portion is delivered by a pump, which, at the time the sample was taken, unfortunately had a loosely-fitting bucket, as a result of which the water was somewhat aërated before being collected. The sample was taken on July 10, 1883, the temperature being 12° C., and the specific gravity at 20°, after keeping a few days, was 1·0092. The water had no perceptible odour, but a decidedly saline taste. It was only very slightly turbid when collected, but the runnings from the pump left a reddish-brown streak, and in the course of two or three hours a bulky reddish-brown precipitate formed in the sample, although it was contained in a stoppered Winchester bottle which had been carefully tied.

Examination for Rare Substances.—A litre of the water was evaporated in a porcelain dish until crystals began to separate. These were removed as they formed, and the concentrated mother-liquor examined. Lithium and strontium were tested for spectroscopically by first fixing the position of a prominent line in their spectra, and then

* Abstract of article in the *Proceedings of the Birmingham Philosophical Society*, vol. iv., part 1, page 38.

searching for a corresponding line in the spectrum of the water residue. No indication was observed of lithium, strontium, or any element which had not previously been estimated, except barium.

A quantity of the mother-liquor was also tested for bromine and iodine. On the addition of chlorine the solution became orange, and on shaking up with ether a distinctly brown extract was obtained which, after washing with water, gave a yellow precipitate with silver nitrate, insoluble in nitric acid, but soluble in ammonia. The mother-liquor on being tested with dilute potassium nitrite, hydrochloric acid, and starch, did not give any indication, and as a single drop of a solution of potassium iodide containing but 0·05 per cent of the salt gave a distinct colour to the test, the absence of iodine was satisfactorily proved.

The results of the analysis may be conventionally represented as follows:—

Sodium chloride	10·4665
Calcium chloride	3·4639
Calcium carbonate	0·6062
Magnesium chloride	0·4671
Oxide of iron and alumina	0·0740
Silica	0·0382
Calcium sulphate	0·0303
Potassium chloride	0·0143
Sodium bromide	trace
Barium chloride	trace
	15·1605

Total solids 15·16 grms. per litre, or 1·516 per cent.

An analysis of this water was performed many years ago by Mr. J. T. Cooper, of London, though no details of the analysis are given. For purposes of comparison I have converted his results into the metric system. The first column contains the results obtained by Mr. Cooper, and the second my own.

Temperature		—	12°
Specific gravity (20°)		—	1·0092
Dissolved gases, per litre		86·5	78·99 c.c.
Consisting of	Carbon dioxide	84	59·97 per cent
	Nitrogen	16	37·89 ,,
	Oxygen	—	2·14 ,,
Composition of Deposit—			
Loss on ignition		—	16·57 ,,
Silica		—	5·00 ,,
Oxide of iron		—	78·26 ,,
Total Solids		1·103	1·516 ,,
Consisting of—			
Sodium chloride		61·76	69·038 ,,
Calcium chloride		23·68	22·849 ,,
Calcium carbonate		1·86	3·999 ,,
Magnesium chloride		9·31	3·081 ,,
Oxide of iron and alumina		—	0·488 ,,
Silica		—	0·252 ,,
Calcium sulphate		—	0·199 ,,
Potassium chloride		—	0·094 ,,
Sodium bromide		—	trace
Barium chloride		—	trace
Iron chloride		0·16	—
Iron carbonate		1·12	—
Magnesium carbonate		2·11	—
		100·00	100·000

It may perhaps be well to point out that from the mere chemical analysis of a saline water it would be unwise to draw any very definite conclusions either as to its medicinal value or as to the precise effect of any single constituent as an agent in the cure of disease. We may, however, compare Salt Wells spring with other and better known saline waters, such, for instance, as Stoke or Droitwich brine and sea water. We have then the following results:—

	Total Solids.	Common Salt.
Droitwich Brine	23·4	22·6
Sea Water	3·5	2 8
Salt Wells	1·5	1·0

We notice in the water from Salt Wells a considerable decrease in the proportional amount of sodium chloride present as compared with the other constituents, notably calcium chloride, and further, as one would naturally expect, we find that the saline springs of the coal measures, where exceptionally such do exist, are not so rich in dissolved mineral matters as are their neighbours in the Trias and Permian formations.

REPORT OF THE COMMITTEE ON INDEXING THE LITERATURE OF CHEMICAL ELEMENTS.*

THE undersigned, a Committee appointed at the Montreal meeting of the American Association for the Advancement of Science, "to devise and inaugurate a plan for the proper indexing of the literature of the chemical elements, respectfully submit the following report.

The members have conferred with each other orally and by correspondence. Several plans have been suggested, and their merits discussed. Three methods of collecting material for the indexes may be named:—

1. Reviewing the Catalogue of Scientific Papers published by the Royal Society (8 vols., 4to).
2. Indexing special journals by different individuals, and collating the matter.
3. The independent plan, whereby each chemist indexes all the journals available to him with reference to a given element, in which he is presumably especially interested.

Each of these schemes is open to objections, and has its difficulties. The first would necessitate an enormous amount of clerical labour, for which volunteers would scarcely be secured; besides, data previous to 1800 could not be obtained from this catalogue.

The second involves, also, securing a large number of self-sacrificing volunteers; and both plans would require a vast amount of editorial work on the part of this Committee.

The third plan seems, to a majority of the Committee, the only feasible one at present. On the independent plan seven indexes have already been compiled.

The best arrangement of material has also been considered; and here again a threefold problem occurs:—

1. Chronologically.
2. Alphabetically, by authors.
3. Topically.

The committee do not venture to dictate to independent workers, but recommend the chronological arrangement, with the understanding that a topical index accompany each monograph.

The best channel of publication has also been considered by the committee. All the indexes hitherto published have been printed in the "Annals of the New York Academy of Sciences;" and the Academy has generously offered, through its officers, to continue its good work. The Smithsonian Institution further agrees to distribute, free of expense, all circulars and documents in furtherance of this undertaking; an offer which is of the greatest importance, and for which this committee expresses sincere thanks.

Since the appointment of the committee, Mr. Webb's Index to the Literature of Electrolysis has been published in the "Annals of the New York Academy of Sciences;" and several chemists have expressed a willingness to coöperate in the proposed undertaking. Prof. R. B. Warder

* From the *Proceedings of the American Association for the Advancement of Science*, Vol. 32, Minneapolis Meeting, August, 1883.

of Cincinnati has promised an index to the literature of the velocity of chemical reactions; Dr. Henry Leffmann of Philadelphia proposes to index the important element arsenic, and Professor C. E. Munroe offers a Bibliography of Explosives.—H. C. Bolton, *Chairman*; Ira Remsen; F. W. Clarke; A. R. Leeds; A. A. Julien.

CANTOR LECTURES OF THE SOCIETY OF ARTS.

The first of the short course of lectures "On the Alloys used for Coinage" (an abstract of which has already been given in the Chemical News, vol. xlix., p. 131) dealt with the mechanical processes incidental to coinage.

In the second lecture Prof. Chandler Roberts traced the history of the changes in composition of the alloys which have from time to time been used. He pointed out that the meaning of the word "alloy" in Mint language is different from that ordinarily accepted in scientific phraseology, as it is applied to the base metal added to a more precious one, and not to the mass, which may be either molten or solidified, of the mixed metals. This use of the word has been fostered by the various Mint indentures, and it has, unfortunately, been perpetuated by the legislative enactment which now guides the currency—the Coinage Act of 1870. The word alloy is probably derived from the latin *ad-ligo*, to bind to, and the Italian metallurgist, Biringuccio, used the word with perfect accuracy in the 16th century. "I have told you," he says, speaking of the gold alloy, "that an alloy only signifies an intimate association (*damicabile amicitia*) of one metal and another."

From the Mint point of view the properties it is most desirable to secure in alloys are:—1st. Ductility; 2nd, Durability; 3rd, Uniformity of Composition. They must have exactly the degree of viscosity which will enable them to "flow" (as Tresca has shown) under pressure into all the fine lines of an engraved die, and they must be sufficiently rigid to enable them to retain the device imparted by the coinage press, for a coin of a soft metal like lead or pure gold would rapidly be reduced to the state of a mere counter by wear.

With regard to Greek and Roman coins, the analysis made by D'Arcet, Dr. Rauch, Lenormant, and by Dr. Flight, have afforded much information as to the composition of the coins of the ancients, and the researches of the above named authorities were referred to at length.

The "curve" of the gold and silver coinages of this country was then described, the co-ordinates being "standards of fineness" and dates of issue.

The gold "curve" begins at the year 1257, the 41st year of King Henry III., who coined pure gold. The standard now in use, 11-12ths pure gold and 1-12th of base metal (or expressed decimally 916·6) was adopted by King Henry VIII. With regard to the silver coinage Professor Roberts offered evidence in support of the view that the "old standard of England," which contains 925 parts of silver in the 1000, dates from Saxon times, and he appealed to the results of assays he has recently made of such early coins. He further showed that from the time of William the Conqueror to Henry VIII. the line of the curve is almost level and unbroken, but it is not a little singular that his assays of coins of King Edward the Confessor proved them to be "better" than standard, as they contained 945 parts of silver in the 1000. The "curves" representing the gold and silver coinages, although in the main continuous, show great "dips" between the reigns of Henry VIII. and Elizabeth, the critical period of our numismatic history at the worst part of which the silver coins only contained 1-4th of their weight of silver.

In conclusion it was pointed out that of all its ancient rights the governing body in the State alone preserves the privilege of issuing coins the intrinsic value of which is slightly less than the value at which they are current, and this right is strictly guarded by law and is only exercised in the public interest.

The questions dealt with in the third lecture did not relate to violent changes of standard, and did not comprise the history either of national disaster or success, but they had a special importance of their own, as they referred to the methods by which the standard fineness of alloys were recognised and maintained. The history of the various methods of assaying gold and silver from those officially adopted at the time of Pliny to the present day was then traced in detail, special attention being devoted to the gradual steps by which the minute accuracy that marks the present methods had been obtained. For instance, Geber, who wrote in the 8th century, gives, if mediæval translations of his works are to be trusted, a sufficiently accurate account of the method of the assay of silver by cupellation to enable the process to be conducted at the present day with no other aid than his, but his description more nearly corresponds to the cupellation of silver as conducted on a large scale with a view to extract silver from lead, than to a mere method of assay. It is interesting therefore to note that in the 12th century the assayer was instructed in conducting official trials of the coin to employ an entire pound weight, and it was not until the reign of King Henry VI. that a record is found of small quantities being taken for the trial; at this later period, however, about 12 grains, or nearly the amount used at the present day, was used.

Much new and interesting evidence as to the weights employed and the details of the methods used in times past was afforded by an examination of certain pieces of gold and silver found in Westminster Abbey, which proved to be the silver "buttons" and gold "cornets" actually resulting from the trials of the Pyx, since the time of Henry VII.

The work of Sir Isaac Newton was alluded to, and the furnace with which he is supposed to have cupelled silver in the Tower of London was exhibited. After the history of the method of assaying gold had been dealt with, Prof. Roberts showed how small a portion of the "remedy," or variation from the exact standards of weight and fineness allowed by law, is actually used at the present day in Mints.

He concluded by saying that these questions might appear to be somewhat abstract and unimportant, but that all questions connected with alloys used for coinage must have had a very vivid interest for those who lived at the period embraced between the reigns of King Henry VIII. and Queen Elizabeth, when the coinage was extremely debased; and at the present day the question was of hardly less importance, because vast commercial transactions were based on the integrity of the British gold coin.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, April 17, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—W. Alabaster, and E. L. C. Muspratt.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Dr. Miller and Mr. Louis, duly elected Fellows of the Society:—J. P. Battershall, W. D. Borland, J. C. Bose, W. D. Crumbie, A. F. Dimmock, H. G. Greenish, W. J. Grey, J. Gaskell, J. W. Pratt, A. G. Perkin, W. H. Perkin, jun., G. H. Wainwright.

Dr. Percy F. Frankland then read a paper on "*The Influence of Incombustible Diluents on the Illuminating Power of Ethylene.*" The present communication forms a sequel to a paper read by the author on the illuminating

power of ethylene when burnt with combustible non-luminous diluents (*Chem. Soc. Journ.*, Jan., 1884). In all cases the gases were consumed from a Referee's burner. Great care was taken to ensure the purity of the ethylene and the diluents (carbonic anhydride, nitrogen, oxygen, and atmospheric air) employed. The author records his observations in a series of tables and curves. He sums up the principal results as follows:—Mixtures of ethylene with the incombustible diluents, carbonic anhydride, nitrogen, aqueous vapour, and atmospheric air, possess a lower illuminating power than pure ethylene. In all mixtures of ethylene with either carbonic anhydride, nitrogen, or aqueous vapour, the intrinsic luminosity of the ethylene is reduced. In mixtures of ethylene with atmospheric air the intrinsic luminosity of the ethylene remains unimpaired until the air forms about 50 per cent of the mixture. Mixtures of ethylene with oxygen in insufficient quantity to form an explosive mixture, possess a greater illuminating power than pure ethylene; the intrinsic luminosity of the ethylene being greatly increased. The disilluminating effects of carbonic anhydride, nitrogen, and water vapour are due partly to dilution and partly to refrigeration, *i.e.*, the cooling occasioned by the introduction of inert gas into the flame; this refrigeration is proportional to the specific heats of the gases, but in the case of carbonic anhydride and aqueous vapour it is augmented by the absorption of heat which takes place in the dissociation of the aqueous vapour, and in the reduction of the carbonic anhydride to carbonic oxide. Of the four diluents, carbonic anhydride, nitrogen, aqueous vapour, atmospheric air, the first is the most and the last is the least prejudicial to the illuminating power; nitrogen and atmospheric air, however, become more equalised in their effects as the proportion in which they are present increases; complete disillumination of the ethylene being effected by the same proportion of each.

Mr. Cross then communicated a paper on "*Trichloro-pyrogallol*," by C. S. S. Webster. Messrs. Cross and Bevan found that by the action of chlorine upon lignose and bastose, chlorinated derivatives were obtained, similar in properties and composition to the derivatives obtained by the action of chlorine upon various astringent substances of natural origin, but while the latter are made up for the most part of compounds which are aromatic in the strict sense of the word, the former contain no compounds of this order but are converted into such under the action of chlorine. These authors also found that the amorphous chlorinated derivative from bastose had certain features of resemblance to the mairogallol of Stenhouse and Groves. The author of the present paper was therefore induced to re-investigate the formation of this mairogallol. He finds that the reaction by which it is formed is divisible into two stages, which can be separated. In the first a trichloro-pyrogallol is formed, and it is this compound which subsequently undergoes condensation to the C_{18} derivative in question. This body—

$$C_6Cl_3(HO)_3 3H_2O$$

was prepared as follows:—To 5 grms. of pyrogallol 12 c.c. of strong acetic acid are added; the mixture is kept cool, and a rapid current of dry chlorine is passed through; in about half an hour the new compound separates as a semi-solid mass of fine needles. The reactions of this body are almost identical with those of tribromo-pyrogallol, giving a deep blue colouration with baryta water, &c. The author has also prepared mairogallol, leucogallol, xanthogallol, and tribromo-pyrogallol, and confirms the statements of Stenhouse and Groves in almost every particular. He has, however, improved the yield of these substances by slightly modifying the original processes.

The Secretary then read the following papers:—

"*The Synthesis of Galena by means of Thiocarbamide*," by J. Emerson Reynolds. Some time since the author noticed that when sulphur urea was heated with an alkaline solution of lead hydrate the lead sulphide was thrown down in a specular layer. In the present paper he gives the best method of obtaining this specular coating on glass, brass, &c. Two solutions are used; one contains 90 grms. of sodium hydrate and 75 grms. of lead tartrate in a litre of water; the other contains 17 grms. of sulphur urea in a litre. Equal volumes of the two solutions are mixed and heated in a clean beaker at about 50°; a specular layer forms on the vessel, which is at first silvery and translucent; it thickens as the temperature rises and becomes opaque, resembling a brilliant face of a crystal of native galena. The excess of the sulphide separates out after boiling a short time as a very dense easily-washed precipitate, having the appearance of a very finely-powdered galena. The author hopes to be able to utilise this separation for analytical purposes. The coating adheres with considerable tenacity to glass, brass, &c., and when the patent rights which control the production of ammonium sulphocyanide lapse, this galena plating may be advantageously applied to many useful purposes. Two glass vases, one coated externally, the other internally, and a piece of brass tube plated with galena were exhibited.

Dr. Armstrong said the author gave no proof that this coating really consisted of galena, *i.e.*, crystallised lead sulphide.

"*On the Analysis of Woodall Spa*," by W. T. Wright. Woodall lies about midway between Lincoln and Boston. In 1811 a boring was made for coal which was abandoned at 277 yards, owing to the rising of a spring. This spring has since acquired some reputation as a medicinal remedy for gout, rheumatism, &c. The properties are apparently due to the bromine and iodine which it contains. The spring was analysed by Dr. Frankland in 1875. The author gives a very complete analysis of the water. It contains 11113·73 parts per million of chlorine, 49·7 of bromine, and 5·21 of iodine. The spring is much richer in iodine and bromine than any other in this country. The author also gives a short account of the geological structure of the district.

"*On the Critical Temperature of Heptane*," by T. E. Thorpe and A. W. Rücker. In a previous paper one of the authors carefully determined the superficial tension of heptane, which was in C.G.S. units at 0° 22·19. From this number the critical point of heptane was calculated to be 281°. Pawleski has shown that a constant difference exists between the critical temperature and boiling-points of strictly homologous compounds. This difference is in the case of hexane 182·3°. Normal heptane boils at 98·4°, which added to the constant 182·3° gives 280·7° as the critical point of heptane.

The Society then adjourned to May 1st.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 10, March 10, 1884.

Mixtures of Detonating Gases. Calculation of Specific Temperatures and Heats.—MM. Berthelot and Vieille.—This memoir does not admit of useful abstraction.

Action of the Electric Effluve upon Oxygen and Hydrogen in presence of Chlorine.—P. Hautefeuille and J. Chappuis.—A mixture of oxygen and chlorine, both chemically pure, traverses an effluve-apparatus without being perceptibly modified. But if traces of nitrogen are added to the same mixture it leaves on the sides of the annular space a slight whitish deposit. This solid matter, if the action is prolonged, forms arborescent crystallisations like those of ice. It resists a temperature of 100°, but is rapidly decomposed without melting at 105°,

emitting hyponitric vapours. It consists of nitrogen, 9·01 per cent; chlorine, 22·71; and oxygen, 68·28. It is probable that bromine and iodine may in like manner combine with nitrogen and oxygen.

Formulæ of Certain Ammoniacal Salts.—R. Engel.—The author concludes that the metallic glyoxylates have the general formula $CH(OH)_2COOM$, and not, as is commonly supposed, $CHOCOOM$. To the acid alcohols of the formula—

$$\left(\begin{matrix}CHOH\\COOH\end{matrix}\right)'$$

there corresponds a particular group of nitrogenous compounds which are neither ammoniacal salts nor amides.

Observations on a Memoir by M. Calmels on the Poison of the Batrachians.—MM. A. Gautier and Etard.—The authors express satisfaction that M. Calmels has confirmed the views put forward in their paper of June 12th, 1882.

No. 11, March 17.

Relative Speed of the Combustion of Detonating Gaseous Mixtures.—MM. Berthelot and Vieille.—Nitrogen delays the combustion of hydrogen and of carbon monoxide, the former in the larger proportion. Mixed gases tend to burn separately, each at its specific rate. The speed of very hydrogenous gases closely approaches that of pure hydrogen, which seems to indicate that the hydrogen burns before the carbon, even in total combustions.

Theory and Practical Formulæ of Magneto-Electric Machines with Alternating Currents.—Felix Lucas.—A mathematical paper, not susceptible of useful abstraction.

On Hall's Phenomena.—A. Leduc.—If the magnetic intensity does not exceed a certain value we may represent the deviation of the equipotential line and of the lines of force at the point where they intersect it by the formula $D=kM(1-at)$, k being the deviation produced at the temperature o° in a point where the magnetic intensity is $=1$, t being a constant which measures Hall's phenomenon in the metal, and a another constant. For bismuth a is very small; for silver its value is 0·008 to 0·009.

Laws of the Decomposition of Salts by Water.—H. Le Chatelier.—The author. referring to the law commonly admitted (see *Comptes Rendus*, June 17th and July 8th, 1872), declares it in absolute contradiction with the experiments of M. Schloesing on the decomposition of calcium and barium bicarbonates, whilst it establishes an analogy—*à priori* improbable—between the reactions by the dry and the moist way. The author seeks to show that we may explain all the facts observed by the ordinary laws of chemical equilibrium, in homogeneous liquid systems, by taking into consideration the insolubility of the compounds produced comformably to the laws of Berthollet,—*i.e.*, by admitting that the insoluble compounds eliminated from the field of the reaction no longer intervene in the state of final equilibrium, which is established exclusively among the compounds in solution. The law at present admitted leads us, on the contrary, to suppose that the equilibrium is established directly between the precipitated and the dissolved bodies.

Action of the Chlorinised Aldehydes upon Benzol in presence of Aluminium Chloride.—Alph. Combes.—The author proposes to apply the reaction of Friedel and Crafts to the chlorinised aldehydes in order to obtain different aromatic aldehydes. He commences this study with chloral. He has obtained one of the three aldehydes theoretically possible, $C_8H_7Cl_3O$.

The Addition of Iodine Chloride to Ethylene Monobromide.—Louis Henry.—The crude product is a very heavy oil, of a brownish colour. When purified it is a colourless liquid, which becomes coloured on exposure to light. Its density at 0° with reference to water is 2·53. Under the ordinary pressure it boils, with partial decomposition, at 193° to 195°,—a result in accordance with theory.

Relations between Plants and the Nitrogen of their Food.—W. O. Atwater.—Maize seems to utilise the mineral matter of manures readily and the nitrogen slightly, and to possess in a high degree the power of appropriating the nitrogen of natural sources. Whilst in its botanical characters it belongs to the cereals, in its physiological relations to plant-food it seems to have a much greater analogy with the leguminous plants. Potatoes are affected by each of the three fertilising agents, superphosphate, potassium salts, and nitrogenous compounds. But they yielded very moderate crops with mineral manures, and responded freely to the nitrogen of manures. Potatoes differ from maize as having less power of drawing sufficient quantities of nutritive elements, and especially of nitrogen, from natural sources. Oats have been still more sensitive than potatoes to the want of nitrogen.

No. 12, March 24.

Action exerted on Polarised Light by Solutions of Cellulose in Schweitzer's Liquid.—A. Levallois.—The author dissolved cotton in Schweitzer's liquid, and, having filtered the solution over asbestos, previously ignited, examined it with the polariscope, using the electric arc as a source of light. With a solution of the strength of 1 per cent he found a deviation of the plane of polarisation to the left equal to about 20°.

MISCELLANEOUS.

THE LABORATORY THAT JACK BUILT,

OR THE HOUSE THAT JACK BUILT ON CHEMICAL PRINCIPLES.

" A little nonsense now and then
Is relished by the wisest men."—*Dante.*

This is the laboratory that Jack built.

This is the window in the laboratory that Jack built.

This is the glass that lighted the window in the laboratory that Jack built.

This is the sand used in making the glass that lighted the window in the laboratory that Jack built.

This is the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the chlorine of yellowish hue, contained in the salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the sodium, light and free, that united with chlorine of yellowish hue, to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the atom that weighs twenty-three, consisting of sodium so light and free, that united with chlorine of yellowish hue to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the science of Chemistry that teaches of atoms weighing twenty and three, and of sodium metal so light and free, that united with chlorine of yellowish hue to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

H. C. B.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bromine.—Professor Thorpe in his interesting lecture on the "Chemical Work of Wöhler" says—"We all know the story of the young chemist whose unscientific use of the imagination cost him the discovery of the element bromine." Will some correspondent of the Chemical News, or perhaps Professor Thorpe himself, give the circumstance alluded to for the benefit of some not acquained therewith?—H. C. B.

MEETINGS FOR THE WEEK

Monday, April 28th.—Medical, 8.30.
—— Society of Arts, 8. "Some New Optical Instruments and Arrangements," by J. Norman Lockyer.
—— Philosophical Club, 6.30 (Anniversary).
Tuesday, 29th.—Institute of Civil Engineers, 8.
—— Royal Institution, 3. "Nerve and Muscle," by Dr. Klein.
—— Society of Arts, 8. "The Transvaal Gold Fields; their Past, Present, and Future," by W. Henry Penning.
Wednesday, 30th.—Society of Arts, 8. "The New Legislation as to Freshwater Fisheries," by J. W. Willis-Bund.
Thursday, May 1st.—Royal, 4.30.
—— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar. Annual Meeting, 1.30.
—— Chemical, 8. "On Benzoyl-acetic Acid and some of its Derivatives," by W. H. Perkin, jun. "On Fluorene," by W. R. E. Hodgkinson.
Friday, 2nd.—Royal Institution, 8. "Krakatoa," by Prof. Judd, 9.
—— Geologists' Association, 8.
Saturday, 3rd.—Royal Institution, 3. "Roman Archæology: the Forum," by Mr. H. M. Westropp.

THE CHEMICAL NEWS.

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THE LATE JEAN BAPTISTE DUMAS.

Another of the few remaining *savants* who have been the contemporaries of Berzelius, Davy, Dalton, Gay-Lussac, and Biot, has passed away from our midst. On the 11th of April Jean Baptiste Dumas concluded his honourable and useful career. He was born at Alais, in 1800, and, like Liebig, he began his chemical career in the establishment of a pharmaceutist. Here, in his twentieth year, he entered upon physiological research, and published, in conjunction with Prevost, the results of a series of experiments on the blood. But, as M. Wurtz remarks, " pharmacy did not absorb him, and physiology could not retain him." He removed to Paris in 1821, devoted himselt entirely to chemistry, and became the pupil of Gay-Lussac. He was soon in a position to undertake, successfully, the most important investigations. With him there began in chemistry a new development amounting almost to a revolution. The views then dominant had been founded exclusively upon the relatively simple study of mineral compounds. All compounds were supposed to be formed of two proximate elements, which might be either simple bodies or combinations of a lower order. The illustrious Swedish chemist, Berzelius, who in the earlier part of the century exercised an uncontested authority, had developed this dualistic hypothesis, and had based it upon his electro-chemical hypothesis. In 1834, however, Dumas, studying the action of chlorine upon certain organic compounds, found that this element " possessed the singular power of combining with the hydrogen of such bodies, and of replacing it, atom for atom." This was the first announcement of a law which is now founded upon thousands of analogous facts, and which is the key-stone of the theory of substitutions. Laurent and Gerhardt ably assisted in the elaboration of this new doctrine. Berzelius opposed it from the very first with all the weight of his ability and his influence. The idea that an electro-negative element like chlorine could take the place of an electro-positive element like chlorine ran counter to his firmest convictions, and, in fact, was necessarily fatal to the entire dualistic system. It involved a new way of regarding chemical combinations. To Berzelius they had appeared as double entities; to Dumas they were unitary structures which might remain unshaken though a course of stones was replaced by other materials. This conception Dumas developed in a series of memoirs on chemical types, a notion which has since been simplified and generalised. In short, it must be admitted that in the creation of what has been called the new, or the post-Lavoisierian chemistry, Dumas played a great—perhaps the greatest—part. It is natural that such a transformation could not be effected without a prolonged and obstinate controversy, and we owe abundance of valuable investigations to the quest for arguments, on the one side to sustain, and on the other to refute, the new views.

This capital discussion, however, by no means sums up the scientific career of Dumas. We find him engaged with the re-determination of atomic weights and with the examination of the law of Prout. He improved existing analytical methods and may be pronounced one of the fathers of gas-analysis. He discovered also not a few organic compounds, which, as Professor Wurtz well remarks, are not isolated beings, but heads of families, the representatives of certain general properties or of certain functions. Thus, in 1830, he discovered oxamide, and in 1835 he studied wood-spirit, in conjunction with his pupil Peligot, and recognised its character as an alcohol.

To his early physiological researches we have already referred. But it must not be forgotten that in his lectures on organic chemistry at the Faculty of Medicine he treated the reactions of the animal economy from a general and an elevated point of view, balancing the losses and the gains and laying the foundations of the chemical statics of living beings. " These memorable teachings," says M. Wurtz, " have exerted a permanent influence, and have introduced into physiology exact methods."

In physics he will be remembered as the inventor of a new method for the determination of vapour densities.

As a teacher of chemistry he takes an exceedingly high rank. Soon after his arrival at Paris he opened a class at the Athénée. Subsequently, in conjunction with Lavallée, Ollivier, and Péclet, he founded the Central School of Arts and Manufactures, where he taught chemistry for more than twenty-five years. In 1832 he succeeded Thénard at the Polytechnique, and was called in the same year as " Adjunct Professor " to the Faculty of Science at Paris. In 1841 he became Titular Professor and Dean of Faculty. In 1844 he succeeded to the Chair of Organic Chemistry at the Faculty of Medicine. Here it was that his professorial career culminated. He was then in the most brilliant epoch of his creative activity. His hearers were fascinated at once with the grandeur and the novelty of his ideas, and with the eloquence and clearness of his exposition.

As may well be imagined, he was often consulted by the Government of the day whenever chemical or physical advice was essential. Before 1848, as Government Commissioner, he had to ascend the Tribune in the Chamber of Deputies, and explain the whole mechanism of coinage, with reference to a Bill before the Chamber. Notwithstanding the dryness of the subject the assembled deputies listened eagerly to a speech which lasted two hours. More recently he was a member of the Commissions on the international use of the metric system and on the establishment of electric units.

In addition to his very numerous memoirs in the *Comptes Rendus* and in other scientific journals, two of his works have become classical—the " Traité de Chemie Appliquée aux Arts," and the " Leçons de Philosophie Chimique," which M. Wurtz styles an " incomparable volume."

The honours which he well merited were not wanting. On the death of Flourens he was elected one of the perpetual secretaries of the Academy of Sciences. On the decease of Guizot he succeeded to his vacant chair at the Académie Francaise—a body which, though its members are for the most part inferior in intellect and in celebrity to those of the Academy of Sciences, is still regarded in France as the superior body.

In 1863 Dumas received from the Emperor Napoleon the Grand Cross of the Legion of Honour. In 1840 the Royal Society elected him a foreign member; in 1843 the same body awarded him the Copley Medal, and in 1869 the Chemical Society awarded to him the Faraday Medal.

At his funeral discourses were pronounced by M. le Compte d'Haussonville, on behalf of the Académie Francaise; by M. Bertrand, his fellow Secretary at the Academy of Sciences; by M. Rolland, President of the Academy of Sciences; by Professor Wurtz, as representative of the Faculty of Sciences and the Faculty of Medicine, of Paris; and by M. Melsens. But the researches of the late chemist are after all his true and his most eloquent eulogy.

Influence of the Density of Detonating Gaseous Mixtures upon the Pressure. Isomeric Mixtures.—MM. Berthelot and Vieille.—The authors conclude that up to the highest known temperatures, one and the same quantity of heat being imparted to a gaseous system, the pressure of such system varies proportionately as its density. The specific heat of gases is distinctly independent of the density, both at high temperatures and near 0°. The pressure increases with the quantity of heat imparted to one and the same system. The apparent specific heat increases parallel to this quantity of heat.—*Comptes Rendus*, No 10, 1884.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Continued from p. 182).

Analysis of Samarskite.

46. A very large quantity (about 15 lbs. weight altogether) of samarskite was worked up, partly by the hydrofluoric acid method of Lawrence Smith,† and partly by fusion with potassic bisulphate. The niobic and tantalic acids after purification were found to give no citron band spectrum.

These methods both gave as a result a large quantity of mixed earths containing most, if not all, of the bodies enumerated in par. 40. Tested in the radiant matter tube, this material gave the citron spectrum very brilliantly. It was dissolved in hydrochloric acid, neutralised as nearly as possible with ammonia, and boiled with sodic thiosulphate. This precipitated the thoria, zirconia, and alumina. In this precipitate some of the scandia might also be found, if present in quantity, but as scandic thiosulphate is not completely precipitated, and the earth is present only in minute traces, not much scandia, it is probable, was thus carried down.

This thiosulphate precipitate, treated in the usual way with sulphuric acid, gave no citron band in the radiant matter tube.

47. The filtrate from the thiosulphate was precipitated hot with excess of ammonia, and the precipitate after washing treated with sulphuric acid, dried, and heated till fumes of sulphuric acid disappeared. The sulphate, whitish with a very pale rose tint, was finely ground, and dissolved with frequent agitation in the smallest possible quantity of cold water—an operation which required much time. The solution was then precipitated with potassic sulphate, taking all necessary precautions to keep the liquid well saturated with potassic sulphate. This operation was allowed to go on for about ten days, when the precipitated double sulphates were filtered off and slightly washed with a saturated solution of potassic sulphate. The precipitate contained cerium, lanthanum, didymium, didymium β, decipium, samarium, scandium, yttrium α, yttrium β, together with any thorium and zirconium which might have escaped the thiosulphate treatment.

48. The filtrate from the double sulphates was precipitated hot with ammonia, which brought down the erbia, holmia, mosandra, terbia, thulia, ytterbia, and yttria. The small quantity of manganese in solution was in this operation completely thrown out.

49. The insoluble double sulphates (45) were dissolved in hydrochloric acid, precipitated hot with ammonia, washed till free from potassium salts, re-dissolved, precipitated as oxalates, ignited, and set aside for further examination. On testing in the radiant matter tube this mixture of oxides was found to be practically free from citron band.

50. The ammonia precipitate from the sulphates soluble in potassic sulphate (46) was well washed till free from potassium salts, and dissolved in excess of nitric acid. The concentrated solution gave an absorption spectrum showing lines belonging to erbium and allied metals. Having already proved that the body I was seeking was not one of those metals which gave an absorption spectrum (42, 43), my first object was to find some method by which I could roughly separate this mixture of earths into two portions, one giving absorption bands, and the other having no action on the transmitted spectrum. I found this was possible by taking advantage of the different solubility of the oxalates in nitric acid.

51. The highly acid solution of the nitrates was fractionally precipitated in the following manner:—

To the boiling liquid a solution of ammonic oxalate was added drop by drop. The precipitate at first formed redissolved on stirring. The cautious addition of ammonic oxalate was repeated until the precipitate refused to dissolve entirely, but left the hot liquid somewhat milky. It was then rapidly cooled with constant stirring, which brought down a heavy crystalline oxalate. This was filtered off, and called oxalate A. The filtrate, again heated to boiling, was precipitated in exactly the same way with a further quantity of ammonic oxalate till the hot liquid became opalescent. On cooling and stirring, a farther quantity of oxalate came down. The filtrations and precipitations were repeated until no more precipitate could be obtained. Usually I could get twelve or thirteen fractionations in this manner; towards the end the solution did not get milky, and it had to stand sometimes twenty-four hours before much oxalate came down.

52. The fractions first precipitated by oxalic acid gave very strong absorption bands when the concentrated solutions of the oxides were examined by transmitted light. The fractions last precipitated showed the absorption bands only faintly.

53. These operations gave me oxalates from A to L. These, ignited, with free access of air, were then each dissolved in nitric acid, and again separately fractionated as oxalates. The result was about 150 precipitates, ranging from A_1 A_2 . . . A_{12}, B_1 B_2 . . . B_{12}, to L_1 L_2 . . . L_{12}.

These, after ignition, were separated into five lots according to order of colour, and the fractionation of each of the five lots repeated as already described; the series of operations now closely resembling those of Pattinson's process for desilvering lead. This gave me about sixty lots. This time the hydrogen equivalent of the metal of each lot was taken by converting the oxalate into sulphate and estimating the sulphuric acid, assuming M_2O to be the type of oxide (40, note 1). The result was a series of earths having hydrogen equivalents (M) ranging from about 48 to 33. The earths were now sorted into high, low, and intermediate, those giving intermediate H equivalents being re-fractionated with repeated H equivalent estimation, the highest and lowest being each time separated and added to the former high and low lots.

54. The ultimate result of about five hundred fractional precipitations gave me a mixture of earths having an H equivalent $M=48$, and showing a strong absorption spectrum (56); a mixture having an H equivalent $M=33$, having no absorption spectrum (65); and intermediate earths.

In the radiant matter tube all these fractions gave the citron-band spectrum well, but that of the earth of lowest equivalent was much the brightest, and that of the highest equivalent the least intense.

55. Three methods are available for the partial separation of these earths and for the complete purification of any one of them. The formic acid process (56, 57) is best for separating terbia, as terbic formate is difficultly soluble in water, the other formates being easily soluble.

Fractional precipitation with oxalic acid (63, 64, 65) separates first erbia, holmia, and thulia, then terbia, and lastly yttria. This is the only method which is applicable for the separation of small quantities of terbia from yttria.

Fusing the nitrates (60, 68, 69) separates ytterbia, erbia, holmia, and thulia from yttria. It is not so applicable when terbia is present, and is most useful in purifying the gadolinite earths. This process is the only one known for separating ytterbia from yttria.

Selection must be made of these methods according to the mixture of earths under treatment, changing the method as one earth or the other becomes concentrated on one side or thrown out on the other. Each operation must be repeated many times before even approximate purity is attained. The operations are more analogous to the separ-

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.
† *Comptes Rendus*, vol. 87, p. 146.

ation of members of homologous series of hydrocarbons by fractional distillation than to the separations in mineral chemistry as ordinarily adopted in the laboratory.

Preparations of Pure Terbia.

56. The mixture of high equivalent earths (54) richest in terbia, erbia, holmia, and thulia was treated as follows:—

The earths were dissolved in dilute formic acid, and the solution heated for some time. A white powder of terbic formate separated. This was filtered off, the solution containing the more easily soluble formates evaporated to dryness, and ignited. In this way the $M=48$ earths were separated into two lots, one rich in terbia and the other rich in erbia, &c. The treatment with formic acid was again repeated on both lots, and the crude terbia finally purified as follows:—

57. The crude terbia from all the operations was systematically treated by the formic acid process, keeping the liquid so dilute that only a portion of the terbic formate separated out each time. The syrupy solution of formates was treated as described further on (60). The hydrogen equivalent of the terbium was taken each time; latterly it kept pretty constant at 49·5. The terbia was also tested in the radiant matter tube. At first the citron spectrum was very strong; gradually, however, it got fainter and fainter under the repeated formic treatment, until finally the spectrum became so weak as to satisfy me that it was due only to impurity in the terbia, and that, had the material been sufficient to stand against the extravagant process of purification adopted, I should finally have got a terbia giving no citron-band spectrum. (Subsequent examination (87) showed me that this terbia did not contain more than 1-5000th part of yttria).

58. A concentrated solution of the purest terbia obtained in this way, when examined by the spectroscope, showed no absorption lines whatever: proving the absence of erbium, holmium, and thulium.

59. The hydrogen equivalent (49·5) would not definitely show the absence of ytterbium (57·9) and yttrium (29·7); but these would have been separated by the formic acid treatment, terbic formate requiring 30 parts of water for its solution, whilst yttric and ytterbic formates dissolve in less than their own weight of water. Moreover, it was not probable that the terbia contained an appreciable quantity of any of these earths as an impurity, for neither the oxalic acid, the fusing nitrate, nor the formic acid process of fractionation produced any change in the atomic weight, 49·5.

Preparation of Mixed Erbia, Holmia, and Thulia free from other Earths.

60. The filtrate from the terbic formate (57), rich in erbia, and containing besides terbia, holmia, thulia, and yttria, was now treated by converting it into nitrates, evaporating to dryness, and submitting the mass to careful fusion, stopping the operation when the liquid mass began to evolve nitrous fumes. The erbic, holmic. and thulic nitrates decomposing before the yttric nitrate, extraction with water gave an insoluble residue rich in erbia, holmia, and thulia, and a filtrate rich in yttria. The insoluble residue was dissolved in nitric acid, again evaporated to dryness, and fused. These operations were repeated eight or ten times, with the result of raising the H equivalent of the erbium metals to about 56·8, but the citron-band spectrum remained strong for some time after. It, however, ultimately disappeared. A concentrated solution of this erbic, &c., nitrate showed a beautiful and intense absorption spectrum. I did not attempt any separation of erbium, holmium, and thulium from each other, as the evidence here obtained is sufficient to show that the element giving the citron-band spectrum is not one of these three metals. Likewise I had far too little material to enable me to enter on a work of such difficulty with any prospect of success.

Philippia.

61. The so-called philippia was sought for in the portion of earths intermediate between the terbia and yttria (54). These were dissolved in dilute formic acid, and the solution, filtered from some terbic formate which would not dissolve, was carefully evaporated down to a small bulk, filtering off the terbic or other difficultly soluble formates as they deposited. The clear concentrated solution was then set aside over sulphuric acid to crystallise. In the course of a few days brilliant rhombic prisms crystallised out, having exactly the appearance described by Delafontaine.* The finest of these crystals were picked out, dried on blotting-paper, and analysed. The hydrogen equivalent was found to be $M=38·2$. The citron-band spectrum in the radiant matter tube was very brilliant. The solution decanted from these crystals was evaporated to a syrupy consistency, filtered from insoluble terbic formate which deposited, and treated for yttria (65).

Some of the best rhombic crystals were added to cold water acidulated with formic acid, and gently heated, but all attempts to dissolve and re-crystallise them failed. A large quantity of an insoluble formate separated, and the mother-liquor on concentration again deposited shining rhomboidal crystals. On attempting to re-crystallise these, they again deposited an insoluble white powder. The mother-liquor was found to contain a large quantity of yttria, and the white insoluble formate on ignition gave an earth having the atomic weight and chemical behaviour of terbia. This entirely corroborates Professor Roscoe's conclusions,† that Delafontaine's philippia is nothing but a mixture of yttria and terbia.

Mosandra.

62. The chemical characters of this earth are so little known that I could not attempt to search for it. But as the citron band-forming earth always appeared concentrated amongst those whose double sulphates were most soluble in potassic sulphate,—and, of these, amongst those having the palest colour and lowest atomic weight,—it was scarcely conceivable that the earth I was in search of should ultimately prove to be one whose properties did not in any case correspond to these,—of a dark orange yellow colour, forming a difficultly soluble double potassic sulphate, and having the very high equivalent of $M=51·2$; these being the properties ascribed to mosandra by the discoverer, Professor Lawrence Smith.

Separation of Terbia and Yttria from Erbia, Holmia, and Thulia.

63. The mother-liquors, from which as much terbic formate as possible had been separated by the process above described (56, 57) were now evaporated down with nitric acid till all the formates were decomposed, and the highly acid solutions of nitrates were fractionally precipitated with oxalic acid (51, 52, 53).

64. The erbic, holmic, and thulic oxalates come down first; then the terbic oxalate; lastly the yttric oxalate (53). After repeated fractional precipitations I at last succeeded in obtaining a mixture of yttria and terbia of a golden colour, which gave a very brilliant phosphorescent spectrum in the radiant matter tube, but showed no trace of absorption band when the concentrated solution of the nitrates was examined in the spectroscope.

Separation of Terbia and Yttria.

65. The crude yttria was now added to the mixture of earths (54) having a hydrogen equivalent $M=33$, and the whole submitted again to fractionation with oxalic acid in a somewhat modified manner.

An excess of strong nitric acid was added to the solution of mixed terbic and yttric nitrates, and the solution was heated to the boiling point. Strong oxalic acid solution

* *Comptes Rendus*, vol. 87, p. 559; CHEMICAL NEWS, vol. 38, p. 202; *Journ. Chem. Soc.*, vol. 36, p. 116.
† *Journ. Chem. Soc.*, vol. 41, p. 277.

was added drop by drop till a faint permanent precipitate was produced. Strong nitric acid was now added, a drop at a time, till the solution again became clear, and the whole was allowed to cool very slowly without agitation. On cooling, an oxalate crystallised out in brilliant prisms. These contained nearly all the terbia with some of the yttria, whilst the mother-liquor contained most of the yttria with a little terbia. The filtrate was treated with more oxalic acid, a fresh crop of crystals being produced, when the crystals were ignited, and the resulting earths re-treated with nitric acid and oxalic acid. After repeated fractionations I finally obtained in this manner a perfectly white yttria and a terbia containing a small quantity of yttria. This terbia was added to the crude terbia from previous operations, and purified as already described (57).

These operations gave me two earths,—yttria and terbia,—which, from the constancy of their H equivalents, were taken to be pure. The earths giving absorption spectra and having H equivalents other than 29·7 and 49·5, include erbia, holmia, and thulia. This portion was not further examined for the purposes of this investigation.

(To be continued.)

NOTE ON THE EMPLOYMENT OF THE ABEL PETROLEUM TESTING APPARATUS IN TROPICAL CLIMATES.

By SIR FREDERICK ABEL, C.B., D.C.L., F.R.S., and BOVERTON KIDWOOD, F.C.S., F.I.C.

It has been pointed out by one of us (*Journ. Soc. Chem. Ind.*, vol. 1., p. 473—478) that the method of testing prescribed by the Petroleum Acts of this country and India is liable to furnish, with one and the same sample of oil, lower results in a tropical country than in a temperate climate, unless certain precautions not specified in the legal directions for applying the test are observed. We found, for instance, that a sample of petroleum which gave a flashing-point of 73° F. when the test was made in the cool atmosphere of the laboratory, flashed on the first application of the test flame at 66° F. when the testing was conducted in an apartment heated to a tropical temperature.

Our earlier experiments led us to think that this difference was less due to the effect of the heated atmosphere upon the oil, during the performance of the operations involved in the process of testing, than to the oil having acquired, by prolonged exposure in closed vessels to a temperature above its flashing-point, a condition (not due, of course, to any chemical change) in which the more volatile hydrocarbons present were less readily held in solution by the hydrocarbons of comparatively low volatility, and were therefore more readily vapourised. We found that when the sample was subjected to prolonged cooling prior to testing, the tendency to exhibit a lower flashing-point was largely diminished. Our attention was afterwards directed to a statement by Dr. Lyon that in the use of the Abel petroleum testing apparatus in Bombay he found it necessary to adopt a special mode of procedure in order to avoid the occurrence of what he termed a *false flash*. The modification suggested by Dr. Lyon consisted in leaving the testing slide withdrawn for some time before commencing the application of the test-flame, and when experimenting under these conditions we found that the depression of the flashing-point was no longer distinctly shown.

It was, therefore, clear that the lower flashing-point was due, at any rate very largely, to vapour disengaged prior to the first application of the test-flame, and that this vapour became dissipated when the modification referred to was adopted.

As the result of further experiments, carried out with the valuable assistance of Dr. Kellner, and many of which were made with the assistance of Dr. Lyon, Chemical Analyser to the Government of Bombay, we expressed the following opinion in a joint memorandum addressed to the Secretary of State for India on June 11th, 1883:—" The liability of petroleum oils to exhibit in tropical countries flashing-points as much as 6° to 7° F. lower than those furnished by the same oils in a temperate climate, which has been demonstrated by experiments at Woolwich and in India, is due to a great extent to the separation of vapour from the oil, consequent upon the agitation of the liquid when the cup of the test-apparatus is filled. The depression of the flashing-point may also be due in part to the effect of a tropical climate upon the oil, or upon the operation of testing."

With the contined assistance of Dr. Lyon we had ascertained the relative merits of various methods of overcoming this effect of a tropical climate upon the flashing-point. In addition to the plan already described, we found that the following methods were available:—

1. The removal ot the collected vapour by means of an aspirator, after placing the cover on the oil cup.
2. The dispersal of the vapour by gently blowing over the surface of the oil, after filling the cup and before putting on the cover.
3. The commencing of the application of the test-flame at a temperature considerably lower than that prescribed by the Acts.

The plan of blowing away the vapour we found simple and effectual in careful hands, but we did not consider it a desirable one to adopt, as it was obviously liable to abuse, and we, with Dr. Lyon, were ultimately led to give the preference to the method of commencing the application of the test-flame at a temperature of 56° F., when the first experiment has furnished a flashing-point below 73° F. The effect of this modification, as well as that of any one of the alternations above mentioned, is to gradually remove the vapour disengaged in the filling of the cup in successive quantities too small to give a flash, each application of the test-flame determining a current of air through the upper part of the cup, and sweeping out a portion of the gaseous contents.

Any one of the modes of operation above described is obviously open to the objection that it effects the removal of some small proportion of the most volatile constituents of the oil (which in all instances is a mixture of liquids differing, and in some cases very considerably, in volatility), and that consequently the character of the sample has sustained some alteration, tending to raise its flashing-point *before* the application of the test-flame is actually commenced. This is, however, unavoidable, and must even occur in tropical climates, to some extent, whenever a sample is subject to any kind of manipulation in the open air; the extent to which the flashing-point is thereby effected, is, however, unimportant in comparison with the value to be attached, from a commercial point of view, to the attainment of uniform results in the examination of cargoes of oils in different countries.

With the method of operating above specified, Dr. Lyon and ourselves expressed the confident opinion that oils, which it had hitherto been impossible to test satisfactorily in India, would furnish concordant results in the hands of different operators, and results not differing to any great extent from those obtained in a temperate climate with the particular oils tested. We did not, however, feel justified in leading the Trade to believe that the Abel test could, even then, be relied upon to give, in all cases, precisely concordant results in different climates; the tendency still being for the instrument to furnish lower flashing-points in a tropical country. We recommended, therefore, that the trade should provide for the liability of some samples to exhibit, when tested in India, a flashing-point as much as three degrees lower than the flashing-point recorded before shipment. It is quite possible that experience may show this to be an unnecessarily wide margin, especially if the flashing-point recorded by the examiner in India be the average of several results, for we believe that it is only in exceptional cases that any

material depression of the flashing-point will be apparent when the test is made by the modified method proposed.

We may point out that the amount of vapour disengaged in the filling of the cup obviously depends upon the precise mode of manipulation, and is, as might be expected, greatest when the oil is poured in slowly in a thin stream from a vessel held some inches above the cup. Under these conditions the considerable agitation to which the liquid is subjected acts mechanically in promoting the disengagement of vapour, while at the same time the attenuated volume of the liquid is exposed to a temperature much above the flashing-point of the oil; these circumstances may combine to cause a layer of vapour to cover the surface of the oil in the cup before commencement of the test. This has even been found to occur in the use of the Abel test in this country in summer weather. As we have already stated, prolonged exposure to a low temperature seems to reduce the tendency of the less volatile portions of the oil to become vapourised; we have not made any large number of experiments in this direction, because lengthened cooling is not a process which recommends itself for practical purposes.

ON THE

FLUID HYDROCARBONS OBTAINED BY THE COMPRESSION OF PETROLEUM GAS.

By GREVILLE WILLIAMS, F.R.S.

WHEN the gaseous hydrocarbons produced by subjecting petroleum to a high temperature are compressed into cylinders, as in the Pintsch system, so much employed for lighting railway carriages, a volatile fluid is condensed containing benzene, toluene, and certain olefines. I have been engaged in the examination of this mixture of hydrocarbons since October, 1882. As I find that Dr. Armstrong is working on the same subject, I think it desirable to give a brief outline of some of the results which I have obtained up to the present time.

The plan I have adopted for the separation of the olefines from the benzene and its homologues is as follows:—I first pass the vapours of the hydrocarbons through a powerful rectifying column. The portions distilling below 66° C. I put aside for the preparation of the olefines which I require for conversion into hydriodates, in order to continue work commenced by me in 1862 (*Journ. Chem. Soc.*, xv., 359). The portions distilling above 66° C. I use for the preparation of benzene and toluene. The olefines may be separated from the latter by agitating the hydrocarbons with a cold solution of permanganate of potassium, as shown by Berthelot; or, preferably, by distilling from dilute nitric acid. By this last method nitro-compounds are produced, which are now under examination.

The nitric acid process properly carried out yields results of considerable precision, the amounts of benzene and toluene obtained in repeated experiments being within one per cent of each other.

The specimens of the hydrocarbon from the various stations where the Pintsch process is carried out differ considerably in the amount of benzene and toluene they contain. Seven specimens with which I was favoured by Mr. Rickman, the Managing Director of the Pintsch Company, gave me the annexed numbers:—

Specimen.	Specific Gravity.	Percentage of Benzene & Toluene.
A	0·850	65·6
B	0·835	54·2
C	0·840	52·0
D	0·830	45·2
E	0·840	44·4
F	0·800	37·8
G	0·760	24·6

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B., Chief Chemist to the U.S. Geological Survey, Washington.

ARSENIC.

FOR the determination of the atomic weight of arsenic two compounds have been studied; the chloride and the trioxide. The bromide may also be considered, since it was analysed by Wallace in order to establish the atomic weight of bromine. His series, in the light of more recent knowledge, may properly be inverted, and applied to the determination of arsenic.

In 1826, Berzelius† heated arsenic trioxide with sulphur in such a way that only SO_2 could escape. 2·203 grms. of As_2O_3, thus treated, gave a loss of 1·069 of SO_2. Hence As=74·840. This is a close estimation; but, being drawn from a single experiment, has so little weight that it need not be included in our final general mean.

In 1845 Pelouze‡ applied his method of titration with known quantities of pure silver to the analysis of the trichloride of arsenic, $AsCl_3$. Using the old Berzelian atomic weights, and putting Ag=1349·01, and Cl=443·2, he found in three experiments for As the values 937·6, 937·1, and 937·4. Hence 100 parts of silver balance the following quantities of $AsCl_3$:—

56·029
56·009
56·016

Mean 56·018 $\pm$ 0·004

Later, the same method was employed by Dumas,|| whose weighings, reduced to the foregoing standard, give the following results:—

$AsCl_3$	Ag.	Ratio.
4·298 grms. $AsCl_3$ =	7·673 grms. Ag.	56·015
5·535 ,,	9·880 ,,	56·022
7·660 ,,	13·686 ,,	55·970
4·680 ,,	8·358 ,,	55·993

Mean 56·000 $\pm$ 0·008

The two series of Pelouze and Dumas, combined, give a general mean of 56·014 $\pm$ 0·0035, as the amount of $AsCl_3$ equivalent to 100 parts of silver. Hence As= 74·829 $\pm$ 0·048, a value closely agreeing with that deduced from the single experiment of Berzelius.

The same process of titration with silver was applied by Wallace§ to the analysis of arsenic tribromide, $AsBr_3$. This compound was repeatedly distilled to ensure purity, and was well crystallised. His weighings show that the quantities of bromide given in the third column are proportional to 100 parts of silver:—

$AsBr_3$	Ag.	
8·3246 grms. $AsBr_2$ =	8·58 grms. Ag.	97·023
4·4368 ,,	4·573 ,,	97·022
5·098 ,,	5·257 ,,	96·970

Mean 97·005 $\pm$ 0·012

Hence As=74·046 $\pm$ 0·058. Why this value should be so much lower than that from the chloride is unexplained.

The volumetric work done by Kessler,¶ for the purpose of establishing the atomic weights of chromium and of arsenic, has already been described in the chromium chapter. In that investigation the amount of potassium dichromate required to oxidise 100 parts of As_2O_3 to As_2O_5

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1.
‡ *Comptes Rendus*, 20, 1047.
|| *Ann. d. Chim. et de Phys.*, (3), 55, 174. 1859.
§ *Philosophical Magazine*, (4), 18, 279.
¶ *Poggend. Annal.*, 95, 204. 1855. Also 113, 134. 1861.

was determined, and compared with the quantity of potassium chlorate necessary to produce the same effect. From the molecular weight of $KClO_3$, that of $K_2Cr_2O_7$ was then calculable.

From the same figures, the molecular weights of $KClO_3$ and of $K_2Cr_2O_7$ being both known, that of As_2O_3 may be easily determined. The quantities of the other compounds proportional to 100 parts of As_2O_3 are as follows:—

$K_2Cr_2O_7$.	$KClO_3$.
98·95	41·156
98·94	41·116
99·17	41·200
98·98	41·255
99·08	41·201
99·15	41·086
	41·199
Mean 99·045 ± 0·028	41·224
	41·161
	41·193
	41·149
	41·126
	Mean 41·172 ± 0·009

Another series with the bichromate gave the following figures:—

	99·08
	99·06
	99·10
	98·97
	98·97
Mean	99·036 ± 0·019
Mean of previous series	99·045 0·028
General mean	99·039 ± 0·016

Other defective series are given to illustrate the partial oxidation of the As_2O_3 by action of air. The foregoing figures give us two distinct values for the molecular weight of As_2O_3. In calculating from the bichromate results the value for chromium deduced from Siewert's determinations will be used, viz., $Cr = 52·009 \pm 0·025$.

From $KClO_3$ series.. ..	As_2O_3 =	197·996 ±	0·049
,, $K_2Cr_2O_7$,, ...	,,	197·777	0·051
General mean ..	,,	197·894	0·035

Hence $As = 75·002 \pm 0·018$.

The general mean for As comes out as follows:—

From $AsCl_3$	As =	74·829 ±	0·048
,, $AsBr_3$	,,	74·046	0·058
,, As_2O_3	,,	75·002	0·018
General mean ..	,,	74·918	0·016

If O = 16, then As becomes = 75·090.

ACTION OF *ASPERGILLUS GLAUCUS* ON CITRIC ETHER IN LEMON-JUICE.

By Dr. T. L. PHIPSON, F.C.S., &c.

Lemons which are placed damp in a cupboard give out after a certain time a very strong odour of ether, which coincides with the development of *Aspergillus glaucus* upon them. When this microphyte penetrates into the interior, or covers the surface of a section of the fruit, the juice on being expressed has also a very strong flavour of ether.

I have been aware of this fact for a considerable number of years (though I have never seen it alluded to), and have often wondered how the ether is produced in these circumstances. But it was not until a short time ago that I observed its production always corresponded with the development of *Aspergillus glaucus* upon the lemons, for the little plant is not always detected at first by the eye alone.

Citric ether may exist in lemon-juice, as acetic ether, for instance, is known to exist in the sap of certain other plants. But citric ether has a very different composition from acetic ether, inasmuch as it contains three equivalents of ether to one of acid; and on being decomposed by *Aspergillus glaucus*, two of these equivalents are probably set free. Such at least is the interpretation I put upon the phenomenon, and this is what, I believe, occurs:—

Under the influence of warmth and moisture some of the *sugar* of the ripe lemon is *fermented*, and the *alcohol* formed immediately combines with the citric acid so abundant in the juice. Citric ether (triethylic citrate) is thus produced, which, under the continued influence of the *Aspergillus*, is split up into free ether and carbonic acid (with, probably, some intermediate products), so that as the action proceeds ether is volatilised into the air around.

In warm weather three or four lemons will thus diffuse a very marked odour of ether through the air of a large room which has remained closed for a few days.

In spite of their well-ascertained anti-fermentative properties, both citric and salicylic acids will in time succumb to the action of microphytes, as I have had many opportunities of observing. Salicylate of lime in solution in water to which dust has access develops a white microphyte in a few months at ordinary summer temperature, abundant filaments of which will be found covering undissolved crystals of this salt.

NOTICES OF BOOKS.

On the Discovery of the Periodic Law, and on Relations among the Atomic Weights. By John A. R. Newlands, F.I.C., F.C.S. London: E. and F. N. Spon, 1884.

In this little volume the author has collected and arranged in chronological order all his contributions bearing on certain relations which he was the first to point out that exist between the numbers that Cannizzarro and others indicated as most probably representing the atomic ratios of the elements, and the chemical analogies of the bodies. A few years after the publication of these papers in the Chemical News the idea of arranging the elements according to their atomic ratios into groups or periods was put forth by Mendeleeff, the scheme being accompanied with a discussion of the chemical facts upon which the arrangement was based. Since the time when Prout endeavoured to show that the atomic weights of all the elements were whole multiples of that of hydrogen a not inconsiderable amount of "circle squaring" play has been indulged in by chemists in attempting to fit these numbers together in the fashion of a Chinese puzzle; as the result of these labours chemistry has not reaped any direct benefit. Indirectly, however, such speculations have done good by stimulating chemists to make more elaborate and exact determinations of the atomic ratios and to a more complete study of chemical analogies, and, more recently, to the properties of some of the rarer earth metals, as cerium, didymium, and lanthanum.

The idea of grouping the elements according to their atomic ratios was first stated by the author of this book, but it was more especially by the labours of Mendeleeff and L. Meyer that it has been raised to a rational hypothesis, and under the name of the periodic law the idea is now considered to be of sufficient validity and importance to merit its introduction into elementary text-books of chemistry.

Mr. Newlands' book has been published not so much

to expound his idea as to further establish his claim of priority as the originator of the periodic law; his claim has indeed been recognised by many writers on the subject, but perhaps in too slight a degree, and the incomplete manner in which the idea was given to the world rendered it eminently liable to be overlooked and ignored in this scrambling age. Mendeleeff, by taking a wide survey of all the chemical facts known relating to each individual element, pointing out the existing analogies between certain of the elements, elaborated the idea and wrought it into a shape acceptable to the scientific mind.

The first paper in the volume was published in the Chemical News for Feb. 7th, 1863, "On Relations among the Equivalents." Such of the elements as exhibit analogous chemical properties are grouped together and a few relations shown to exist among the equivalent weights of the members of each group. The chief points noticed are, the existence of triads in the several groups, that is, groups of three analogous elements, the equivalent weight of one element being the mean of the other two, which was noticed by Döbereiner, in 1829; and the fact that "if we deduct the member of a group having the lowest equivalent from that immediately above it, we frequently observe that the numbers thus obtained bear a simple relation to each other."

In the second paper on "Relations between Equivalents," published July 30th, 1864, a complete table is given of the elements, arranged in order of their equivalent weights, also a shorter one containing about half the known elements formed into natural groups, and the triads noticed. In this table lithium is grouped with magnesium, zinc, and cadmium, the three latter forming a triad; so too nitrogen, phosphorus, arsenic, antimony, and bismuth, from a group of which the three intermediate members constitute a triad. In the group of which boron forms the first member there are no three analogous elements given which might be considered as a triad; two of these blanks have since been filled by the discovery of indium and gallium, at least so the author tells us in his preface. In the next group, comprising carbon, silicon, and tin, the two latter are the extreme members of a triad, the mean position being blank. With regard to this arrangement the explanatory remarks contained in the paper state that "silicon and tin stand to each other as the extremities of a triad. Titanium is usually classed along with them, and occupies a position intermediate between silicon and the central term or mean of the triad, which is at present wanting; thus, $\frac{\text{Si } 28 + \text{Sn } 118}{2} = 73$ mean of triad, and $\frac{\text{Si } 28 + \text{mean of triad } 73}{2} = 50{\cdot}5$, the equivalent of Ti being 50." Thus, as the preface points out, twenty years ago the author drew attention to the missing link which Mendeleeff has predicted and named eka-silicium.

The most important papers contained in this volume bearing on the periodic law are those published in the Chemical News, August 18th and 25th, 1865, on the "Law of Octaves" and "on the Cause of Numerical Relations among the Equivalents," respectively. In the first note the elements are arranged into vertical series of sevens in order of atomic weights, the horizontal members forming a natural group. The elements are numbered 1, 2, 3, up to 56. The first vertical series from 1 to 7 comprises hydrogen, lithium, glucinum, boron, carbon, nitrogen, and oxygen; the second series, from 8 to 14, begins with fluorine, ending with sulphur, including the elements whose equivalents lie between these extremes. In this manner eight vertical series are formed; a few transpositions, however, are made in the consecutive numbering of the elements so as to bring analogous elements into the same horizontal row. Grouped in this fashion "it will also be seen that the members of analogous elements generally differ either by 7 or by some multiple of seven; in other words, members of the same group stand to each other in the same relation as the extremities of one or more octaves in music. Thus, in the nitrogen group, between nitrogen and phosphorous, there are 7 elements; between phosphorus and arsenic, 14; between arsenic and antimony, 14; and lastly, between antimony and bismuth, 14 also." This relationship the author provisionally named the "Law of Octaves."

The other paper consists of an endeavour to show that "all the numerical relations among the equivalents pointed out by Dumas and others, including the well known triads, are merely arithmetical results flowing from the existence of the 'Law of Octaves,' taken in connection with the fact of the equivalents forming a series of numbers approaching to the natural order." This last "fact," however, is far from being even allowable as a reasonable assumption, considering the possibility of "predicted" elements turning up. The elements here are again numbered consecutively, in order of equivalent weights, and as an illustration one of the consequences that follow from the arrangement is described in these words:—"Now, in conformity with the 'law of octaves,' elements belonging to the same group generally have numbers differing by seven or by some multiple of seven—that is to say if we begin with the lowest number of a group, calling it 1, the succeeding members will have the numbers 8, 15, 22, 29, 36, &c., respectively. But 8 is the mean between 1 and 15; 15 is the mean between 8 and 22; 22 is the mean between 15 and 29, &c., and, therefore, as an arithmetical result of the 'law of octaves' the number of an element is often the exact mean of those of two others belonging to the same group, and, consequently, its equivalent approximates to the mean of their equivalents." In a similar way it is shown how by this method some other numerical relations among the equivalents may be explained.

In an appendix to the work a few short papers are added, published since Mendeleeff's first contribution to the periodic law, containing more recent speculations on the subject and to vindicate the author's priority in the matter.

The main feature contained in these short papers is the idea of arranging the elements into groups of seven, to each group being allotted those elements which may be considered more or less analogous in chemical character; the way, however, in which this is done is based on too hard and fast lines, leaving little margin for future discoveries. That there should be only seven groups probably agrees best with our present knowledge, or occasionally admitting an eighth or long period, still it would be premature to attach too much value to the hypothesis, which may gain much strength or even fall by the discovery of one or two new elements, or some particular properties of those already known. Comparing the order in which the author of these papers grouped the elements together twenty years ago with the tables that have been drawn up in recent years by writers on the subject, making sufficient allowance for the considerable increase of our knowledge since then, one cannot help being struck by the great similarity between the schemes; indeed, so much so does this appear to us to be the case that we think had Mr. Newlands continued his speculations with the advance of science he might have made the subject all his own. As it is, to him is due the honour of first propounding the idea of periodicity among the elements, and surely the phrase "law of octaves" differs little from that of "periodic law" except by its special meaning. That Mendeleeff and Meyer indeed have done much, no doubt independently, to devise and develop the scheme no one can doubt, and our own Royal Society has amply honoured them for their labours. They more especially have laboured to show that the physical as well as chemical properties of the elements are periodic functions of the atomic ratios, and by so doing have given another auxiliary to the chemist to aid him in his researches. The discovery of gallium, and more recently of scandium, which were predicted, or more reasonably the finding that the atomic ratios of these elements, combined with their properties,

filled up certain lacunæ in Mendeleeff's table, have given the greatest interest to speculations concerning periodicity among the elements, and there is no lack of enthusiasts who see in the periodic law the basis of much further discovery. It has taught chemists that besides classing the elements into groups of somewhat similar bodies each element of these groups may be looked upon as a member of another distinct group of elements possessing among themselves quite distinct properties, and that in passing from one to the other of these last groups there is a recurrence or periodicity in the properties displayed.

The law cannot be said to be a numerical one, but what may be the views it will lead to regarding the constitution of matter, or whether it will even render the performance of one single experiment with a known element unnecessary, owing to the capacity for predicting phenomena which the amplification of the idea may acquire, can only be decided by a vast amount of experimental work for a long time to come.

Théories et Notations Chimiques. Premières Leçons du Cours professé à l'Ecole Polytechnique. Par Edouard Grimaux, Professeur à l'Ecole Polytechnique. Paris: Dunod. 1884.

There is certainly little cause for complaint, on the part of our elementary students of chemistry, of the insufficiency, in point of numbers, of small text-books on the science within their reach; but as to variety in the method of treating the subject, that is quite another thing. Supply in such a matter as book-making is exactly regulated by the demand for the same; and if it be the sole aim of the science-teachers at our schools to labour to impart the principles of chemistry under such a guise that may enable their pupils to grasp the idiosyncracies of some examiner or another, we cannot reasonably feel surprised at the kind of pabulum supplied through each stage of growth till the other side of the examination-room is reached.

There is a great deal of elementary matter connected with the fundamental principles of chemistry which we think could, with much advantage to the student, be introduced into our smaller manuals were the writers a little less anxious to compile a volume "to suit the requirements" of such and such a board of examiners, but more mindful of the hypotheses that underlie all formulæ.

This little book is well put together, and is intended as an introduction to the study of chemistry. In its scope, however, it is something more than an introduction, and to follow the author in his discussions through the various chapters requires some modicum of facts to assist the reader. Of the two parts into which it is divided the first contains, for an elementary work, a full and clear account of the fundamental hypotheses employed by the chemist. In the first few chapters the laws of definite and multiple proportion are explained and criticised, as well as the terms equivalent, proportional number, atomic and molecular weight. In the discussions of these matters Avogadro's hypothesis, Dulong and Petit's law, and the law of isomorphism are introduced, and the value of each of these hypotheses analysed in their application to the points in question, as well as the facts that have been brought to light by the study of the phenomena of dissociation. Newlands' and Mendeleeff's idea is explained, and the aid the periodic law offers to the classification of the elements; a chapter, too, is given to the much-discussed subject of atomicity.

In the second part an account is given of the different notations that have been proposed by Berzelius, Dumas, Gerhardt, and by Berthelot, and the alterations that have taken place in the values assigned to the atomic weights traced.

In an appendix Avogadro's paper on a method of determining the relative masses of the molecules of bodies, and the proportions according to which they enter into combination, as well as an extract from one of Ampère's papers, and another by Gaudin on molecules and atoms, are given.

The clear account which this little book gives of the theories and notations of chemistry is rendered more valuable by the historical aspect the author has given it.

CORRESPONDENCE

CURE FOR NITRIC ACID BURNS.

To the Editor of the Chemical News.

Sir,—Some weeks ago, in experimenting with "brown fuming nitric acid," I happened to splash a portion of this powerfully corrosive liquid upon the skin of the face. The pain caused, I need hardly say, was very acute, and in a few minutes an enormous blister arose upon the part affected. Copious application of cold water, then of such powerful bases as ammonia, potash, and lime in water, had no perceptible effect upon it, except perhaps to increase the violence of the inflammation. After a few minutes, however, I luckily bethought me to try the effect of a dilute solution of sulphurous acid, of which I had a good supply made but a short time previously. Assuming that the action of the strong nitric acid was an intensified process of oxidation, I cast about for a reducing agent which might safely be trusted to be innoxious, even if it did not afford much relief. The effect of its application was astounding. In a very few minutes the blister was reduced; the oxidising process of the strong acid was completely arrested, without having reached the roots of the hairs on the face; the painful irritation was completely removed, and in an incredibly short space of time the wound healed.

I do not write to suggest a repetition of such a painful though interesting experiment, but to record the result of my experience for the benefit of others.—I am, &c.,

A. Irving.

Wellington College, April 29, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 4, 1883.

On Electrolysis.—H. Schucht.

Qualitative and Quantitative Separation of Bismuth and Copper.—Dr. Julius Löwe.—Already inserted.

Preparation of Bismuth free from Arsenic and on the Atomic Weight of Bismuth.—Dr. Julius Löwe.—The process for obtaining a non-arsenical bismuth is described in detail at great length. The mean atomic weight of the metal is $Bi = 207 \cdot 330$ (if $O = 15 \cdot 96$) or $207 \cdot 845$ (if $O = 16 \cdot 00$.

Determination of Alcohol in Examinations of Beer by the Halymetric Method.—Dr. Kleinert.—This memoir does not admit of useful abstraction.

Wine Analysis.—Dr. J. Moritz.—The author determines total acidity with decinormal alkali, using rosolic acid as indicator; extract by the direct process; ash in the usual manner; glycerin according to Neubauer and Borgmann's method; alcohol by means of Geissler's vaporimeter, after a preliminary distillation; phosphoric acid by the uranium method in the ash of 100 c.c. of the sample; sulphuric acid direct in 50 c.c. of the wine after

acidification with hydrochloric acid; specific gravity by means of Westphal's balance and polarisation with Wild's polaristrobometer in a tube of 200 m.m. in length.

Determination of the Acetic Acid in Wine by Distillation with Watery Vapour.—Dr. B. Landmann.—This paper cannot be usefully reproduced without the accompanying figure.

On the Application of a Current of Air saturated with the Vapour of Bromine for the Precipitation of Manganese.—N. Wolff.—In the laboratories of iron works, manganese is generally separated from iron by repeated precipitation of the latter with sodium acetate. The manganese precipitated from the united filtrates by means of bromine contains alkali, and cannot be used at once for the determination of the manganese. This difficulty may be got over by using ammonium acetate instead of the corresponding sodium salt. The author uses instead of bromine-water a current of air saturated with bromine vapour. The formation of nitrogen bromide is then not to be feared; the precipitation of the manganese is complete; the possible impurities of the bromine do not affect the result, the consumption of bromine is smaller, and the process requires less time.

Behaviour of Silver Chloride, Bromide, and Iodide, with Bromine and Iodine.—Paul Julius.—Inserted in full.

A New Exsiccator Tap.—Paul Julius.

On a Reconstruction of Lintner's Pressure-Flask.—A. Gawalowski.

An Extraction-Apparatus.—A. Gawalowski.

Apparatus for Generating Gas.—Dr. P. Seidler.—These four papers describe improvements in apparatus which cannot be intelligibly described without the accompanying figures.

On Breaking-up Chrome Iron.— H. Schwarz.—The author protests against the statement of H. N. Morse and W. C. Day, that the silver crucibles used are rapidly attacked. The silver from which the crucible is made should be allowed to cool very slowly, so that it may not be rendered porous by "spitting." A well-made crucible will serve for at least 100 operations. The author allows the residue after lixiviation to be dried and slightly ignited; extracts the ferric oxide with hydrochloric acid and opens up again. If the chrome-ore has been previously well elutriated there is seldom more than a trace of chromic acid obtained in this second operation. The determination is effected by running the solution of potassium chromate into an acid solution of ferrous sulphate in excess, and titrating back with permanganate. An inversion of the process involves error, since chromic chromate is then easily formed and readily escapes reduction.

The Phosphorescence of Sulphur.—H. Schwarz.—Pale phosphorescent flames are often observed during the drying of gunpowder.

The Relative Proportions of Glycerin and Alcohol in Beer.—E. Borgmann.—The proportions fluctuate but little; the maximum observed was 5·497 glycerin to 100 alcohol, and the minimum 4·140.

Determination of Relatively Small Quantities of Alcohol in Glutinous Liquids.—E. Borgmann.—The author puts 100 to 200 grms. of the substance into a roomy flask, fitted with a cork having two perforations. In the one is a bent tube which merely passes through the cork and is connected at the other end with a condenser and a receiver. Through the other passes a tube bent at right angles, its longer end passing down nearly to the bottom of the flask, whilst the other is connected with any convenient steam-generator. The flask is fixed in a water-bath and by means of the current of steam all the alcohol is quickly driven out of the glutinous mass and into the receiver.

Tension of Mercurial Vapours.—Hagen and Hertz.—The authors give a tabular view of their results.

Examination of Spices.—E. Borgmann. — Tables showing the proportion of essential oils in different samples of pepper, cinnamon, mace, cloves, and pimento.

Action of Organic Acids upon Minerals.—H. Carrington Bolton.—From the Chemical News.

Spectral Analysis.—H. W. Vogel.—The author gives an explanation of the phenomena observed by Lockyer. He holds that the bright lines of incandescent gases may be modified in their position by the presence of other gases. Thus the differences in the spectra of certain bodies observed by Lockyer may be due to the presence or absence of other bodies.

On Photographing the Spectra of Sparks.—W. N. Hartley.—From the *Proceedings of the Royal Society*.

Method for Examining the Absorption of Light by Coloured Solutions—O. Tumlirz.—The liquid to be examined is placed in a hollow prism, with its refractive edge upwards, and running horizontally, in front of the vertical slit of the spectroscope.

Spectroscopes with Great Dispersion.—Ch. V. Zenger.—From the *Comptes Rendus*.

Improvements in Polarising Apparatus. — L. Laurent.—From the *Comptes Rendus*.—Similar improvements have been devised by F. Lippich and R. Landolt, and are figured in the *Zeitschrift für Instrumentenkunde*.

A Thermo Regulator.—F. P. Dunnington.—This instrument cannot be intelligibly described without the figures appended in the original.

An Instrument for the Correction of Gas-Volumes.—A. V. Harcourt.—From the *Proceedings of the Royal Society*.

An Apparatus for Observing and Measuring the Elimination of Oxygen from Green Plants.—T. Weyl.—This paper requires the accompanying figure.

Improvements in Balances and Weighing.—E. Brauer and Cuno Rumann.—For particulars we must refer to the original memoirs.

A Modification of the Pyknometer.—E. Wiedemann.—Air is expelled from pulverulent bodies not by boiling, but by means of the mercurial pump.

Manufacture and Correction of Burettes.—W. Ostwald.—From the *Journal fur Prakt. Chemie*.

An Improved Pipette.—A. Meyer.—The author has devised an arrangement suitable for poisonous or corrosive liquids.

On Experimentation in Fused Tubes—E. Drechsel.—From the *Journ. fur Prakt. Chemie*.

Preparation of Asbesto Filters.—P. Casamajor.—From the Chemical News.

Capsules of Asbestos Paper—J. Bering. — The moistened paper is moulded to the required concavity.

Removal of Residues of Precipitates from Glass Vessels.—A. Müller.—The author uses small tongue-shaped pieces of vulcanised india-rubber, supported by a stout wire inserted at the back.

Preservation of Oxygen Gas in Zinc Gasometers.—Julius Löwe.—The author recommends the use of lime-water instead of pure water.

Preservation of Hydrofluoric Acid and Fluorides.—E. Militz.—The author lines glass bottles with a layer of gutta-percha. He dissolves the gutta-percha in carbon disulphide, pours it into the bottle (which must be quite dry); allows the liquid to come in contact with all parts of the inner surface; pours out the excess, if any, and lets the bottle stand until the solvent has evaporated. Caoutchouc stoppers are required.

Preparation of Hydrobromic Acid. — Rother.—Bromine is allowed to act upon sulphur in presence of water. The sulphuric acid formed is neutralised with magnesia and the hydrobomic acid is distilled off.

Development of Sulphuretted Hydrogen.—J. R. de Luanco.—This paper requires the accompaning illustration.

Method for Obtaining Sulphuretted Hydrogen—J. Taylor.—From the Chemical News.

Detection of Arsenic in Undiluted Sulphuric Acid.—H. Hager.—The author places in a clean test-tube 3 to 4 c.c. of the acid and a little stannous chloride, shakes up well, applies heat, and boils for half a minute. If arsenic is present the acid takes a yellowish or brown colour; if the acid is pure it remains colourless. Nitric, nitrous, and sulphurous acid as well as organic matter must not be present.

Purification of Carbon Disulphide.—L. H. Friedburg and Obach.—From the Chemical News and the *Journ. fur Prakt. Chemie.*

The Electrolytic Deposition of Mercury, Tin, and Cobalt.—W. Gibbs.—From the Chemical News.

The Analysis of Silicates.—W. Knop.—This paper has been inserted in full.

Determination of Small Quantities of Sodium Chloride in Presence of Potassium Chloride.—G. Ulex.—The filtrate, after separation of the potassium chloride as the double platinum salt, containing sodium-platino-chloride and excess of platinum chloride, is mixed with a solution of sal-ammoniac. The ammonio-platinum salt is collected upon a filter, the filtrate evaporated to dryness, the volatile salts are expelled by heat, the residue extracted with water, the chlorine is determined by titration with silver, and the corresponding quantity of sodium chloride is found by calculation.

Determination of Titanic Acid.—P. T. Austen and F. A. Wilber.—An examination of the method of G. Streit and B. Franz, from the *Amer. Chem. Journ.*

Quantitative Determination of Zinc.—L. Schneider.—Zinc sulphate in aqueous solution up to 1 grm zinc in ½ litre water is almost entirely precipitated by sulphuretted hydrogen. The quantity remaining in solution is about 2 m.g. zinc per litre. At 1·7 grm. zinc. per ½ litre the precipitation is incomplete. In presence of free sulphuric acid the precipitation of zinc by sulphuretted hydrogen is perfect only when the proportion of hydrated acid does not exceed 1 c.c. per litre. Under the above-mentioned conditions as to concentration and acidity zinc may be separated by means of sulphuretted hydrogen from iron, manganese, nickel, and cobalt. From very dilute hydrochloric and nitric solutions zinc may also be completely precipitated by means of sulphuretted hydrogen. In accordance with the above facts the author determines zinc in its ores as follows:—1 grm. of the dry ore is placed in a long-necked flask with 10 c.c. sulphuric acid, and according as it is calamine or blende with 1 or 2 c.c. nitric acid, until white vapours of sulphuric acid escape. When cold the flask is placed in a sloping position, and 70 c.c. water are cautiously added. Roasted ores, and all such as are not soluble in nitro-sulphuric acid, are first dissolved in hydrochloric acid and then evaporated with sulphuric acid. Into the hot dilute solution there is passed sulphuretted hydrogen without previous filtration, and thus copper, arsenic, and antimony, free from zinc, are precipitated. After the gas has been passed in for 15 minutes it is heated to a boil, until the excess of sulphuretted hydrogen is expelled. The precipitate, consisting of the sulphides of the above-mentioned metals with lead sulphate and insoluble gangue-stone, is collected upon a filter and washed with sulphuretted hydrogen water. The filtrate which amounts to about 200 c.c., is mixed, boiling hot, with ammonia to incipient turbidity. The precipitate is re-dissolved with a few drops of sulphuric acid, and after the solution has been diluted with water to 500 to 600 c.c., the zinc is precipitated by means of sulphuretted hydrogen.

The Reduction of Solutions of Ferric Salts.—P. T. Austen and G. B. Hurff.—From the *Amer. Chem. Jour.*

Detection of Traces of Fluorine in Silicates.—W. Knop.—The finely-ground mineral is placed in a small tubulated retort, covered abundantly with sulphuric acid, and dry air is passed through, keeping the mixture at 50° to 60°. The gaseous current is caused to pass out to the bottom of a narrow glass cylinder, 20 c.m. in height, filled to about one-fourth with a solution of a few decigrms. of colourless aniline in 30 c.c. of a mixture of equal parts of aniline and ether. The current of air must be so regulated that a single bubble per second may pass through the aniline solution. If the current is thus kept up for two hours, if a small quantity of fluorine was present, there is found in the lower end of the delivery-tube as far as it dips into the aniline solution a white deposit. This may be easily removed with the feather of a pen and rinsed by immersion in the liquid. On adding 3 drops of a moderately strong solution of caustic soda in absolute alcohol the turbidity loses its crystalline glittering appearance, and within a quarter of an hour a cloud of sodium silico-fluoride settles to the bottom of the cylinder. The author believes that a milligramme of fluorine may thus be distinctly recognised.

Method for the Direct Determination of Chlorine in Presence of Bromine and Iodine, and of Bromine along with Iodine.—This paper will be noticed at some length.

Determination of Sulphur in Pyrites.—G. Lunge.—For effecting this determination in the wet way the author uses an aqua-regia of 1 part strong hydrochloric acid with 3 of nitric acid from 1·36 to 1·40 spec. gr. He finds on further examination that it is not advisable to use a nitric acid of above 1·42 spec. gr.

The Determination of Sulphur.—C. Bodewig.—Inserted in full.

Determination of Nitric Acid.—J. West-Knights.—From the *Analyst.*

The Spectra of the Carbon Compounds.—G. D. Liveing and J. Dewar.—From the Chemical News.

The Distinction of Primary and Secondary Amines and Phosphines from Tertiary.—H. Gal.—From the *Bulletin de la Soc. Chimique.*

Behaviour of Thymol and Carbolic Acid with Reagents.—E. Hirschsohn. — From the *Pharmaceutical Journal.*

A Sensitive Reaction of Phenol.—J. F. Eykman.—A very dilute solution of phenol mixed with a few drops of nitrous ether, and the same volume of undilute sulphuric acid, takes a red colour. If the acid is allowed to run down the side of the glass so as to form a layer below the phenol solution there appears a narrow red band where the liquids meet. This reaction indicates 1 part in two millions.

The Composition of Cacao Oil.—M. C. Traube.—The author has been unable to find the theobromic acid of Kingzett, nor indeed any other acid except the oleic, lauric, palmitic, stearic, and arachic.

Occurrence of Free Fatty Acids, rich in Carbon in Vegetable Fats.—E. Schmidt and H. Römer.—The authors find in these fats very considerable quantities of free acids.

The Detection of the Different Starches.—W. H. Symons.—From the *Pharmaceutical Journal.*

On α and β Amylan.—C. O'Sullivan.—From the *Journal of the Chemical Society.*

On Levulose.—MM. Jungfleisch and Lefranc.—From the *Comptes Rendus.*

Action of Potassa upon Glucose.—A. Emmerling and G. Loges.—The authors obtain a compound which reduces Fehling's solution in the cold.

On Andromedatoxine.—P. C. Plugge.—An account of a non-nitrogenous, poisonous compound obtained from *Andromeda japonica.*

Conversion of Ferric Hydroxide into Ferric Oxide.—C. Bodewig.—The author places the precipitate and the ash of the filter in a porcelain crucible, moistens with nitric acid, dries, and weighs, repeating these operations a second time. The oxide thus obtained is free from ferrous oxide, whilst pure pulverulent ferric oxide ignited for five minutes in an open, upright platinum crucible, over a small Bunsen flame, on solution in hydrochloric acid gave a blue precipitate with potassium ferricyanide. If the platinum crucible is placed slanting, half covered with its lid, reduction takes place also, though to a less extent. It is evident that the reductive gases of the flame diffuse themselves through the ignited bottom of the crucible.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Carbonate of Ammonia.—Can you, through your columns, give me any information, or tell me where I can get any information, as to the process of manufacture of commercial carbonate of ammonia? I believe it is made near Manchester in considerable quantities.—Ammonia.

MEETINGS FOR THE WEEK

Monday, May 5th.—Medical, 8.30. Ann. Oration.
— Society of Chemical Industry, 8. "On the Composition and Illuminating Power of Coal-gas," by Dr. Percy Frankland. "On the Estimation of the Illuminating Power of Gas Burners, especially those of large size," by W. J. Dibdin.
— Society of Arts, 8. "Some New Optical Instruments and Arrangements," by J. Norman Lockyer.
— Royal Institution, 5. General Monthly Meeting.

Tuesday, 6th.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Photographic, 8.
— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.

Wednesday, 7th.—Society of Arts, 8. "Bicycles and Tricycles," by C. V. Boys.

Thursday, 8th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
— Society of Arts, 8. "Cupro-ammonium Solution and its use in Waterproofing Paper and Vegetable Tissues," by C. R. Alder Wright.

Friday, 9th.—Royal Institution, 8. "Mohammedan Mahdis," by Prof. W. R. Smith, at 9.
— Society of Arts, 8. "Indigenous Education in India," by Dr. G. W. Leitner.
— Astronomical, 8.
— Quekett Microscopical Club, 8.

Saturday, 10th.—Royal Institution, 3. "Roman Archæology: the Palatine Hill," by Mr. H. M. Westropp.
— Physical Society, 3.

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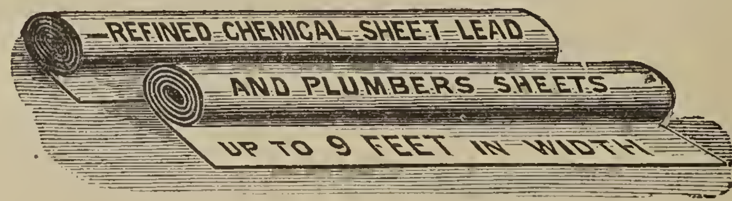

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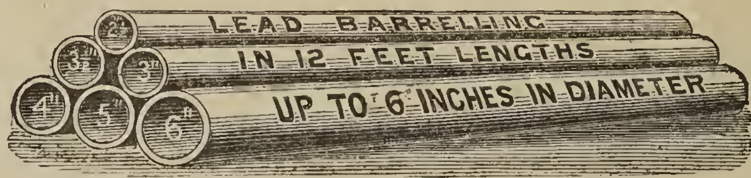

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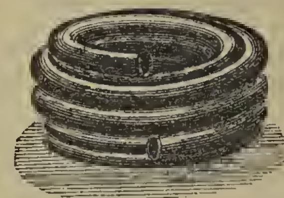

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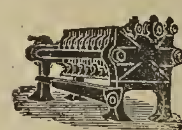


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THE CHEMICAL NEWS.

VOL. XLIX. No. 1276.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Concluded from p. 196).

Ytterbia.

66. Before considering it finally proved that the substence forming the citron-band spectrum was yttria, it was necessary to prepare ytterbia and ascertain its behaviour in the radiant matter tube, this earth and yttria being the only remaining earths to which the citron spectrum could possibly belong.

The two metals have hydrogen equivalents—ytterbium 57·9 and yttrium 29·7. The chemical reactions are also sufficiently different to render their separation a matter of no very great difficulty.

67. Gadolinite is said by Nilson to contain most ytterbia, so this mineral was chosen in preference to samarskite. The crude earths were first purified from all the earths whose sulphates are difficultly soluble in potassic sulphate (22, 25, 31 to 36), then by the formic acid process from terbia (56, 57), and lastly by fractional precipitation with oxalic acid from the erbia earths (65). There remained an almost white yttria, which gave the citron-band spectrum very brilliantly. Now, gadolinite contains only about 0·1 per cent of ytterbia, and about 35 per cent of yttria; therefore the ytterbia to yttria in this mixture was somewhat in the proportion of 1 to 300, and it gave the citron-band spectrum as brilliantly as I had ever seen it. The probability was that the earth forming nearly the whole was the one giving the spectrum.

68. Ytterbic nitrate decomposes on fusion almost as easily as erbic nitrate (60), whilst yttric nitrate resists decomposition much more energetically.* Fusion of the nitrates is also the best process for throwing out the erbia, holmia, and thulia, and is therefore the best for purifying gadolinite yttria, as this mineral is rich in the erbia earths and contains little terbia.

The gadolinite yttria was converted into nitrate, fused for a short time, and extracted with water. The portions soluble and insoluble in water were again separately submitted to this treatment, until at last a colourless earth was obtained, the nitrate of which decomposed easily on fusion, and another whose nitrate resisted decomposition when exposed for a long time to nearly a red heat (70).

The earth from the easily decomposed nitrate gave at first a faint citron-band spectrum, evidently due to impurity. On repeating the operation several times I at last succeeded in obtaining a white earth which gave only the merest trace of citron-band spectrum. Its hydrogen equivalent, 58·0, and its chemical properties showed that it was probably Marignac's ytterbia. Subsequent experiments satisfied me that this earth did not contain more than 1-10,000th part of yttria (84, 87). The extreme tediousness of the chemical operations necessary to obtain this high degree of purity, and the long time they require, prevented me from pushing these results beyond what was necessary to prove the special point at issue.

* Marignac, *Comptes Rendus*, vol. 90, p. 902.

Purification of Yttria.

69. The white earth obtained in the operation described at par. 65 might still contain traces of terbia, together with erbia, holmia, and thulia. I had relied on the absence of absorption spectrum as proving the absence of erbia, holmia, and thulia, but this test is not a very delicate one, and a final purification was therefore attempted. The decomposition of the fused nitrates was now the process relied on for this final purification, the yttric nitrate resisting nearly a red heat without decomposition, whilst the erbic, holmic, and thulic nitrates are decomposed at a much lower temperature. The operation was carried on as described at par. 60.

The yttric nitrate left undecomposed, after repeated fusions, was now fused at a higher temperature, extracted with water, filtered from insoluble residue, and the operation repeated on the filtrate. After several such operations the H equivalent of the yttria was taken at every succeeding operation, and the spectral appearance in the radiant matter tube was also examined. The equivalent gradually got down to 31·0, but the spectra did not vary very much; that from the earth of lowest equivalent being, however, the most brilliant.

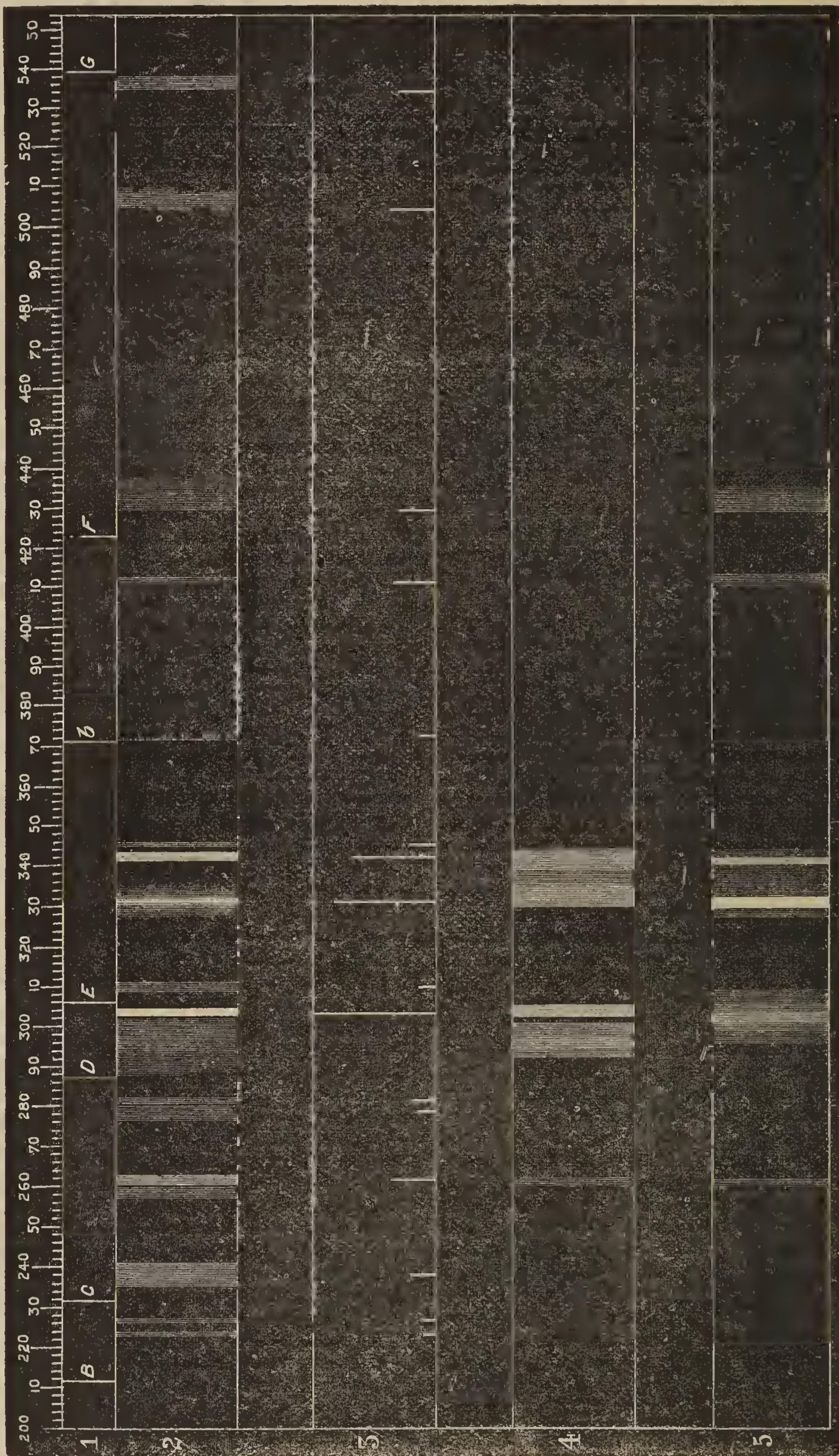
70. The yttric nitrate, prepared from gadolinite and freed from ytterbia by the fusion of the nitrates (68), was converted into oxalate and ignited. The resulting yttria was quite white, and on testing in the radiant matter tube gave a spectrum absolutely identical with that given by the zircon (18), cerite (25), thorite and orangite (33, 34), and samarskite (64, 69), yttrias. Pure yttria was also prepared from yttro-tantalite, euxenite, allanite, tyrite, and also from plaster of Paris (15) and common limestone. In no case could I detect any difference in the position or intensity of the lines shown by their phosphorescent spectra.

The Phosphorescent Spectrum of Yttria.

71. The spectrum shown by pure ignited yttric sulphate in a radiant matter tube is one of the most beautiful objects in the whole range of spectroscopy. The lines are not so sharp as those given by spark spectra, but are more like the flame spectra of the alkaline earths. The spectrum is best seen under low dispersion and not too narrow a slit. The accompanying cut gives an accurate map of the spectrum. I have given in line No. 1 the position of the principal Fraunhofer lines for comparison of position. Line No. 2 gives the position of the bands, and No. 3 the relative intensities represented by the heights of the ordinates. The numbers along the top refer to a scale of squared oscillation frequencies, or of the squared reciprocals of wave lengths.

72. Commencing at the red end, two narrow faint bands are seen at 2245 and 2275, followed by a stronger and broader red band extending between 2355 and 2415. Another faint band occurs between 2577 and 2610, followed after a very narrow black interval by a stronger reddish orange band extending to 2627. Another faint orange band occurs at about 2800, with edges too indistinct for measurement. At about 2940 a faint yellow band appears, extending to about 3025. The strong citron-coloured band follows closely from 3028 to 3049; and a little further on, between 3100 and 3120, a much fainter citron band is seen. Two characteristic green bands follow after a dark interval; the first, very bright, extending between 3312 and 3320, but shading off on each side; the second somewhat fainter, but more sharply defined than the first, extending from 3420 to 3440; there is also a third faint green band, between 3460 and 3467. At 3730 is the centre of a narrow and faint bluish green band; at 4110 to 4125 in a blue band; and at 4296 another blue band commences, and, extending a short distance, fades away so gradually as to render measurement of the further side impossible. At 5052 and 5351 are two violet lines, but they are not sufficiently sharp to enable accurate measurements to be taken.

I have carefully compared the spark spectrum given by yttric chloride with the phosphorescent spectrum, and have not found any similarity between them, neither have I de-



tected any discontinuity of spectrum on examining the faint light shown by yttrium compounds in Becquerel's phosphorescope.

73. The above description applies to the spectrum shown either by pure yttria or by an earth tolerably rich in yttria. When traces are present the citron band only is seen. A little more yttria brings out the first and then the second green band, and finally, as the proportion of yttria increases, the red and blue bands appear (80 to 86).

Circumstances modifying the Yttria Spectrum.

74. In the early days of this investigation I frequently found that an earthy mixture which by one mode of treatment gave no spectrum, would give a good citron band by a modification of the treatment, and I gradually found that I was most likely to get the spectrum when the body had been treated with sulphuric acid and then ignited to dull redness (4). Not knowing the circumstances govern-

ing the appearance of the citron band, it would not then have been safe to have altered this mode of treatment. Now, however, having ascertained the earth to which the spectrum was due, and having a considerable quantity at my disposal, experiments were tried on other methods of treating yttria before exposing it in the radiant matter tube.

75. Pure yttria precipitated by ammonia from the sulphate was dried at a temperature below redness and tested. It did not phosphoresce in the slightest degree, and, necessarily, no citron-band spectrum was to be seen. The yttria was removed from the tube, converted into sulphate, heated to redness, and again tested. It now gave the citron band magnificently. This shows what apparently trivial circumstances will alter the whole course of an investigation. In 1881, when searching for discontinuous phosphorescent spectra, I tried a similar experiment with pure precipitated yttria (45), and entirely missed its citron-band spectrum. Had I first treated the yttria with sulphuric acid, instead of testing the earth itself in the radiant matter tube, the results would have been very different, and this research would probably have never been undertaken.

76. Yttria was now prepared by igniting the precipitated oxalate at a red heat. On testing in the radiant matter tube it phosphoresced with feeble intensity, the light being about one-twentieth of that given by the ignited sulphate under similar conditions. The citron band was almost as sharp as the sodium line, and was shifted one division towards the blue end, now occupying the position 3050 to 3060, its former place 3028 to 3049 being quite dark. The appearance is shown in line No. 4. On superposing this spectrum and that from the ignited sulphate the displacement of the citron bands was clearly observed; with a very narrow slit the two bands were seen not to touch. The two green bands were visible, but very hazy and indistinct, and only to be resolved into bands with difficulty. The yttria was now removed from the tube, ignited to a bright red heat, and re-tested. The spectrum was a little stronger than that given by the yttria ignited at a lower temperature, but in other respects the general appearance and measurements were unchanged. No alteration was caused by subsequent ignition to a white heat.

77. Pure yttric sulphate ignited to a bright white heat gave a spectrum corresponding to the oxide (76); the sulphate having been decomposed by the high temperature.

78. Yttric phosphate was precipitated, washed, and dried at a heat below redness, and introduced into the radiant matter tube. It phosphoresced faintly, giving the citron band hazy and faint, extending from about 3010 to 3060. The red bands were faint, and the green bands, especially the first one, were stronger than usual. The salt was now removed from the tube, and heated to redness. It became of a grey colour, and now phosphoresced with a beautiful green light. The citron band was still broad and faint, but the green bands were very bright and distinct, and the red band between 2610 and 2627 was also stronger. The spectrum No. 5 shows the appearance.

Heating the phosphate before the blowpipe made little change in the character of the phosphorescence. It was moistened with sulphuric acid, heated to a dull redness, and then tested, but no further change was produced in the spectrum. This experiment shows that the citron-band test for yttrium is far less delicate in the presence of phosphoric acid than in its absence.

Occurrence of Yttria in Nature.

79. It is an old and probably a true saying that every element could be detected everywhere had we sufficiently delicate tests for it. Early observations (10, 16) had prepared me for the wide distribution of the element giving the citron band, and no sooner had the exquisite sensitiveness of this spectrum test forced itself on my notice than I sought for yttrium in other minerals. Facts which I had noticed in connexion with the variation of the appearance of the citron spectrum, according to the quantity of yttrium present, showed that it might be possible to devise a process for the rough quantitative estimation of yttrium, and after several experiments this was ultimately carried out in the following manner:—

The calcic carbonate which was found to give no citron band (12) was boiled in a quantity of nitric acid insufficient to dissolve it. The solution was filtered from the insoluble residue, diluted to a convenient bulk, and standardised: 14·91 grains of solution contained 1 grain of calcium. This operation was performed in a room in which had been no yttria compound, and the chemicals and apparatus were new, and had not been taken into the general laboratory. A portion of the standard solution was precipitated with ammonic oxalate, and the calcic oxalate ignited and treated with sulphuric acid. Tested in the radiant matter tube it gave no citron band.

Pure yttric sulphate was dissolved in water to such a strength that 3000 grains of solution contained 1 grain of yttrium.

80. The solutions were mixed together in the proportion of 1 of yttrium to 100 of calcium, evaporated to dryness, and ignited with sulphuric acid, and the residue tested in a radiant matter tube. The spectrum was bright, the citron band, the two green bands, the blue, and the red bands showed distinctly.

81. A mixture was now prepared in the proportion of 1 of yttrium to 500 of calcium, and tested as above. The citron band was strong, but the green bands were fainter; the blue bands were still visible.

82. A mixture containing 1 of yttrium to 1000 of calcium was next prepared. In the radiant matter tube the citron band was almost as strong as in the last experiment, but the edges were not so sharp, the blue bands were faint, and the green bands had disappeared.

83. A mixture containing one of yttrium to 5000 of calcium tested in the radiant matter tube showed the citron band still very bright, but hazy about the edges. No other bands were seen.

84. A mixture of 1 yttrium and 10,000 of calcium was now tried. The citron band was still decided, but not at all sharp.

85. One of yttrium to 100,000 of calcium was next prepared and tested. The citron band was faint, but easily seen. It could not, however, be obtained at all sharp, and appeared broader than usual.

86. A mixture of 1 of yttrium and 1,000,000 of calcium was lastly prepared, and tested in the radiant matter tube. The citron band was very faint, but there was no mistaking its presence, and with care I have no doubt a smaller quantity than 1 in 1,000,000 could be detected. This, however, appears to be near the limit of the test.

87. These seven tubes were mounted on a board, so that connection with the induction coil could rapidly be made to either of them; and various minerals, &c., were prepared and tested in radiant matter tubes (10). By comparing their spectra with those of the standard tubes I could, after a little practice, determine roughly the proportion of yttrium present, supposing the test not to be interfered with by the presence of phosphoric acid (78).

88. The following are some of the most interesting results obtained in this way:—(See Table on next page).

Indications of other Spectrum-yielding Elements.

89. Throughout the course of this paper I have devoted myself only to the citron-band spectrum. I do not, however, wish it to be thought that no other spectra were obtained. On the contrary, I have repeatedly seen indications of another very beautiful spectrum characterised by a strong red and a double orange band, and, more rarely, of a third spectrum distinct from the other two. These I am investigating, but not yet having obtained definite results I forbear from saying any more about them. I hope that they may bear sufficiently good fruit to be worthy of presentation at some future time to the Royal Society.

		Parts.
Pink coral (one partiticular specimen)	One part of yttrium in	200
Strontianite	One " "	500
Stilbite	One " "	500
Hydrodolomite, from Vesuvius	One " "	500
Witherite	One " "	1000
Arragonite	One " "	2000
Chrondrodite (Humite), from Vesuvius	One " "	4000
Egyptian syenite (Cleopatra's Needle)	One " "	7000
Calcite	One " "	10,000
Natrolite	One " "	10,000
Ox bone	One " "	10,000
Meionite (Vesuvius)	One " "	10,000
Meteorite (Alfianello, Feb. 16, 1883)	One " "	100,000
Brevicite	One " "	200,000
Prehnite	One " "	500,000
Thomsonite	One " "	500,000
Vesbine, mixed with lava, from Vesuvius	One " "	700,000
Dolomite	One " "	1,000,000
Tobacco ash	One " "	1,000,000
Leucite, from Vesuvius	Less than one "	1,000,000
Nepheline, from Vesuvius	None	
Meteorite (Dhurmsala, 1860)	None	
Analcite	None	
Phenakite	None	
Chrysolite	None	
Haüynite	None	
Turquoise	None	

ON THE DETERMINATION OF PHOSPHORUS IN IRON AND IRON ORES.

By ADOLF TAMM, Ph.D.

In 1859 Prof. Eggertz communicated to the *Jernkontorets Annaler* his accurate and complete enquiry into the quantitative estimation of phosphorus by weighing the precipitate obtained on the addition of an ammoniacal molybdate solution to a phosphoric acid solution. This process has ever since formed the basis of the molybdate method used for the estimation of phosphorus in iron and iron ores. Many chemists prefer to precipitate phosphoric acid by means of a magnesia solution, and weigh the magnesic pyrophosphate, usually after precipitating by the molybdic solution, but sometimes without such previous precipitation. After many years' experience in the chemical analyses of iron and iron ores, &c., I have not yet found any reason to depart from Eggertz's simple molybdate method. Comparative experiments always gave the same result as the magnesia method, pre-supposing that each method was executed by observing the same necessary care.

Phosphorus Determination in Iron.

I pointed out in the *Jernkontorets Annaler*, 1883, p. 74, that certain measures of precaution must be observed in regard to the method of dissolving the iron, if the phosphorus shall be obtained completely precipitable by means of the molybdic solution; but these precautions are alike necessary whether the molybdate precipitate be weighed direct, or again dissolved for determination as magnesic pyrophosphate.

In order to test the results of phosphorus determinations in iron by several different methods, also performed by other chemists, I obtained the assistance of E. Bergman and E. Trotz. In all 67 analyses were made upon nine different samples, embracing cast-iron with varying amounts of phosphorus, iron wire, and cast steel. Four methods of solution of these were tested against each other. Then the various methods of precipitation and weighing were tested, such as the molybdate method, in which the molybdate precipitate was weighed direct; the molybdate magnesia method in which precipitation by ammonium molybdate preceded precipitation by the magnesia mixture; and lastly an acetate of magnesia method, in which by means of acetate of soda the phosphoric acid is precipitated in combination with ferric oxide, to be afterwards dissolved, precipitated, and weighed as magnesic pyrophosphate.

For *the solution* of the iron, and its further treatment before precipitation with ammonium molybdate, several different methods have been tested by me, of which the following, A, B, C, and D, may be cited as employed in this investigation:—

In method A the iron is dissolved in nitric acid of 1·20 sp. gr., and for every gramme of iron use 12 c.c. The solution is made by boiling upon a hot iron plate, or gas flame; boil briskly till dry, heat the dried iron salt for an hour at the melting-point of tin or about 200°. Then dissolve in hydrochloric acid of 1·19 sp. gr.; use for each grm. iron about 6 c.c. The solution is again boiled quickly till dry, then again dissolved with hydrochloric acid in the same way, evaporate the excess acid as much as possible without drying any portion of the iron salt. Water is now added to one or two times the volume of the solution, about 5 c.c., and the silica filtered off.

I have found the strong drying of the nitric acid solution, *without the previous addition of hydrochloric acid*, to be the surest means of obtaining the phosphorus completely precipitable with ammonium molybdate. The second drying is, on the other hand, not necessary for the complete extraction of the phosphorus, but because it requires little time, and the silica is thereby made easier to filter off, and according to my experience in most cases saving time.

This method of solution, which I recommended as the most certain in my paper last year, has also in the series of analyses performed by Bergman and Trotz given the highest and the most trustworthy results.

In method B the iron is dissolved in nitric acid, evaporated to dryness, re-dissolved in a mixture of 3 c.c. hydrochloric acid and 2 c.c. nitric acid, diluted with 4 c.c. water for each grm. of iron, then filtered from the silica.

In many comparative trials I have for several years found that this method of solution gave the same results as by solution in nitric acid, without pushing the evaporation to dryness but only to half its volume, then dilute with water and filter.

In both of these methods the precipitation with ammonium-molybdate gave only two-thirds to three-fourths of the amount of phosphorus. In many comparative tests I made by this method, most of the results were alike low when the molybdate precipitate was weighed as such, or,

when precipitated with the magnesia solution. The loss by this method does not depend upon incomplete solution of the iron, for in those found low I have fused the silica in soda, separated the silica by the usual method, and on the addition of ammonium molybdate no phosphorus precipitate was obtained.

In method C the iron is dissolved in nitric acid as in A, boiled till the solution thickens, hydrochloric acid of 1·19 sp. gr. is added (6 c.c. for each grm. of iron), the boiling continued till dry, and heated for an hour to at least 200°, dissolved in hydrochloric acid, and excess evaporated, diluted, and filtered from the silica.

This method with ammonium-molybdate has certainly sometimes yielded the same result as by A, but often lower, even to a tenth part less than those obtained by A. To obtain phosphoric acid by C method completely precipitable by ammonium molybdate I have found it necessary after drying to heat to about 300°; but this temperature is difficult to obtain on an iron plate—it injures the glass vessels, and solution according to A is preferable.

Some chemists dissolve the iron in aqua-regia, or add hydrochloric acid immediately after nitric acid without previous boiling, but I have found that the danger of obtaining yet lower results is greater than according to the method C, although the difference in small amounts of phosphorus is certainly not noticeable.

In method D the solution of the iron is made as in C, with this difference, that, after the addition of hydrochloric acid, the boiling is not continued to dryness, but only as long as none of the iron salt is dried; water is then added and the silica filtered off.

This method is not recommended, because the silica clogs the filter and requires an unreasonably long time for filtration.

These results show that the strong drying according to C does not help to make the phosphoric acid more completely precipitable than only boiling with aqua-regia, without any drying, according to D. Both these methods give certainly in general too low results, but one so much higher than the method B, for a great part of the phosphoric acid according to B remains unprecipitable. This must be accepted in method D as changed to precipitable only by boiling with strong aqua-regia. Then, that phosphoric acid which, after dissolving iron in nitric acid, is unprecipitable by ammonium molybdate, but becomes precipitable through the strong drying according to method A, cannot be explained by inferring that the phosphoric acid by drying is brought into combination with oxide of iron and thereby converted into a precipitable form. Rather, the evident result of method D gives further support to the opinion expressed in my former paper on this subject—that the cause of the phosphoric acid in iron dissolved in nitric acid, being partly unprecipitable by ammonium-molybdate, is to be ascribed to the organic acids which are formed in the solution by the combined carbon. That these acids are completely destroyed when treated according to method A is seen from this: that white cast-iron, according to this method, always gives solutions and molybdate precipitates of a pure yellow colour, on the contrary, such iron, especially according to method B, but also according to C and D, gives solutions and precipitates with a more or less strong brown colour, proceeding from these acids. This opinion concerning the action of the carbon is not contradicted by the fact that the phosphoric acid can be completely precipitated in combination with ferric oxide, for then the power of the organic acid to maintain it in solution is annulled by the previous neutralisation. My view, therefore, is that we can, as a general rule, prescribe for phosphorus determination in iron; that its solution shall be treated in such a manner as that the action of the organic acids be suppressed, either by being themselves destroyed, or by neutralising and precipitating the phosphoric acid in combination with ferric oxide. The former seems to me the simplest, and can be most certainly attained by the A method of solution.

The molybdate method of precipitating and weighing phosphoric acid is usually applied by me in the following way:—

The solution filtered off from the silica is taken in a beaker which has been washed in ammonia and rinsed with pure water, but not dried with a cloth; otherwise the molybdate precipitate adheres to the bottom and sides of the beaker. To avoid much wash-water use the smallest filter, yet not so small as to unduly prolong filtration.

For 1 grm. iron the filtered solution should not exceed about 20 c.c., or for 5 grms. 50 c.c.; add a similar volume of molybdate solution.

This *solution is prepared* according to Eggertz's prescription by dissolving 100 grms. pure molybdic acid, or the corresponding amount of hydrate, in 422 c.c. ammonia of 0·95 sp. gr., and while stirring the solution add 1250 c.c. nitric acid of 1·20 sp. gr.; or by dissolving 123 grms. crystallised ammonium-molybdate in 333 c.c. ammonia of 0·95 sp. gr. and 62 c.c. water, and to the solution add 1250 c.c. nitric acid of 1·20 sp. gr.

If the amount of phosphorus in the iron is large, up to several tenths of one per cent, add more molybdate solution, so that for every 0·001 grm. phosphorus use an excess of 2 c.c. molybdate solution. Heat up the solution now for 4 hours to 40°, then syphon off the clear solution with a glass syphon having a hole blown in the side of the tube 1 c.m. above the end of the short leg introduced into the beaker, by which it is possible to remove the bulk of the solution without any of the precipitate following. That phosphoric acid is completely precipitated by this method I have tested by adding to the syphoned solution, either more molybdate solution or ammonium nitrate, and heating to 40° or higher without any weighable precipitate being obtained. Neither have higher results been obtained by addition of ammonium nitrate before the molybdate solution, nor by (Troilius's method) addition of hydrochloric acid before completely drying, and then evaporate until dry, and all red fumes have ceased.

The precipitate is taken upon a filter of not more than 2 inches diameter, which has been dried at 120° and carefully weighed. In performing many analyses it is not necessary to dry all the filters before weighing. Satisfactory results may be got by weighing filters undried, and then immediately after drying at 120° determine the moisture, and from their weight calculate the amount per cent lost by drying. It appears that the percentage of moisture in filters weighed at the same time is usually alike, and that upon various occasions filter-paper at chamber temperature commonly shows very small variations. The usual moisture amounts to 5 or 5·5 per cent of the weight of the undried paper, and for a filter of 5 centimetres diameter it seldom varies more than from about 0·0005 to the highest, 0·001 grm., but this amount of phosphorus precipitate from 1 grm. iron corresponds to not more than 0·001 to 0·002 per cent of phosphorus. When no very great accuracy is required, all drying may be neglected, and the weight of the undried filter reduced by 5 per cent of its weight.

Washing of the molybdate precipitate is done with water containing 1 per cent nitric acid of 1·20 sp. gr., by which it is not sensibly dissolved under the short time required, although it tends to dissolve under prolonged treatment with nitric acid and water. The washing may be accelerated by suction, and in the absence of other arrangements for this purpose, a very speedy washing is obtained by connecting to the end of the filter-funnel—with a short piece elastic tube—a glass tube 20 to 30 centimetres long, bent a little above the middle into a full turn. With this arrangement* the filtration and washing may be completed in 20 minutes. The washing is continued as long as an iron reaction is obtained with ferrocyanide of potassium, or till a drop evaporated leaves only a perceptible spot, and any long interruption must be avoided, because the precipitate is thereby made sensibly

* Figured in Fresenius's "Quantitative Chemical Analysis," p. 78, as Piccard's.

soluble. I have ascertained that an extra washing with the above nitric acid water does not tend to dissolve the precipitate. Two analyses of some eight phosphorus estimations of iron were treated identically; only one set was washed with double the amount of nitric acid water than the other; the results did not differ more than 0·001 per cent; five of the eight double washed being each reduced by that amount.

As soon as the washing is finished, place the funnel in an air-bath heated to 120°, and after drying remove the filter with pincers, and as soon as it feels only sensibly warm to the back of the hand place it point downwards in tared weighing tubes, or porcelain crucible, and weigh. For small amounts of phosphorus the drying is usually finished as soon as the filter appears bluish-green. The drying and weighing commonly takes about half an hour. Greater amounts of phosphorus require somewhat longer time. The precipitate dried at 120° contains 1·64 per cent phosphorus.

That this method gives most satisfactory results is shown by the agreement between the analyses made by it, and by that according to the magnesian methods when the solution is made in the same way. The method of treatment adopted in phosphorus precipitation is based in all its details upon Professor Eggertz's investigations, even in respect to the improvements which have been introduced by degrees, to obtain speedier results, as in drying at 120° instead of 100° as formerly.

If arsenic is found absent this method can be further accelerated by heating the molybdate solution to 50° before adding it to the boiling iron solution, and filtering after lapse of an hour. In this way I have in many comparative trials obtained the same results as in those made according to the above method of procedure.

Experiments prove that there is no special necessity in precipitating with molybdate solution to add ammonium nitrate, or to wash the molybdate precipitate either with ammonium nitrate or with diluted molybdate solution.

The close agreement between the results by the *acetate magnesia method* of Mr. Riley (*Journ. Chem. Soc.*, March, 1878) and that obtained by the molybdate method after solution according to method A, are in general so good that the former may be regarded as evidence of the accuracy of the latter method. The molybdate method possesses the same accuracy as the magnesia method, but attained with greater speed.

If very large amounts of phosphorus (over 1 or approaching 2 per cent) are to be determined, the drying and weighing of the molybdate precipitate is admitted to be difficult, and in such cases the molybdate magnesia method after solution according to A may be preferable. Such great amounts of phosphorus in iron are so seldom met with that the weighing of the molybdate precipitate will present no difficulty. But in phosphorus determinations in superphosphates and similar substances, the weighing of the molybdate precipitate will be too difficult, and therefore precipitation with magnesia solution is necessary.

The acetate magnesia method is too tedious to recommend for practical iron analyses, but as a check in doubtful cases made by the molybdate method, it is much more preferable than the molybdate magnesia method, for the former process, from beginning to end, rests upon quite other principles than the latter, though if the iron is not correctly dissolved the results will have the same error as in the molybdate method.

Concerning the amount of phosphorus in iron, I have found that it is not always so uniformly distributed as we in general seem inclined to accept. Thus from cast-iron produced from the same materials the phosphorus varies from 0·020 per cent to 0·027 per cent, or from 0·024 per cent to 0·030 per cent. This may depend upon the variation of the amount of phosphorus in the ore as well as in the fuel; but it may also in some proportion proceed from more or less phosphorus being expelled in the blast-furnace gas or removed in the slag.

In iron or steel ingots produced by the Bessemer process, it is usual to find again the full amount of phosphorus present in the pig-iron, but in hearth refined iron the amount of phosphorus is commonly somewhat less than in the cast-iron used; at the same time a part of the phosphorus from the cast-iron is oxidised and removed in the slag. In iron made in the Lancashire hearth the phosphorus amounts to two-thirds or three-fourths of that in the cast-iron from which it is made when special care is taken to reduce the phosphorus as low as possible; but when such care is not taken the phosphorus in the iron often varies from two-thirds to the full amount of that in the cast-iron, and in some few cases a bar or two may have the amount of phosphorus exceed that in the cast-iron; this is not difficult to explain when it is remembered how easily phosphorus is sometimes reduced from the slag. This danger is thought to be less in the Walloon process than in the Lancashire hearth, and iron made in the Walloon hearth in general contains at most two-thirds down to the smallest trace of the phosphorus present in the cast-iron used. The amount of phosphorus met with in bar-iron varies not merely in the separate bars but also in different parts of the same bar.

The Determination of Phosphorus in Iron Ores.

The finely pulverised ore is commonly dissolved either in aqua-regia or in strong hydrochloric acid; the latter appears to be the most serviceable in effecting speedy solution. Special care must be taken to ascertain that the ore is digested sufficiently long with acid before proceeding to evaporate for separation of the silica. Drying at a higher temperature gives the same results as drying on the water-bath. After separation of the silica proceed in the same way as in the phosphorus determination in iron.

I have met with only one iron ore that contained phosphorus somewhat insoluble in acids. This ore—in which occurs the mineral pyrophyllite—gave on dissolving in hydrochloric acid 1·19 sp. gr. 0·242 per cent phosphorus. After fusion with soda, dissolving in aqua-regia, and separation of silica in the usual way, the ore gave 0·743 per cent phosphorus.

The most certain phosphorus estimations in iron ores are obtained by fusion with soda—2 grms. is sufficient for 1 grm. ore; dissolve in aqua-regia; separate silica in the usual way, and precipitate the phosphoric acid from the filtrate as in the process for iron.

ON THE CHANGES WHICH TAKE PLACE IN THE CONVERSION OF HAY INTO ENSILAGE.

By FREDK. JAS. LLOYD, F.C.S.,
Lecturer on Agriculture, King's College.

The recently published number of the *Royal Agricultural Society's Journal* contains some information upon the subject of silage which appears to me of considerable interest to those chemists who are at present investigating the changes which take place in the conversion of grass into silage. The data* are, so far as I know, unique, and though the analytical work is not my own, yet it is that of an agricultural chemist, Mr. A. Smetham, of Liverpool, whose work I know from personal experience to be thoroughly careful and reliable. I have therefore no hesitation in basing my remarks upon it.

We have here for the first time an accurate account of the quantity of grass put into a silo, of the quantity of silage taken out, and of the exact composition both of the grass and resulting silage. I desire merely to place myself in the position of, so to speak, a "chemical accountant."

* *Royal Agricultural Society's Journal*, vol. xx., Part I., pp. 175 and 380.

The ensilage has been analysed at three depths, or rather in three layers, the first being 1 foot, the second 1 ft. to 1 ft. 6 in., and the third 1 ft. 6 in. to 2 ft. from the bottom of the silo. By doubling the figures of the bottom layer analysis, adding these to the second and third layer analysis, and dividing by 4, we obtain a fair representation of the average composition of the silage taken throughout the silo, for by so doing we obtain the average of the analyses of each 6-inch layer of silage. The results of the analyses are as follows, calculated on the dry matter. The moisture was practically the same, being 70·48 per cent in the grass and 72·97 in the silage.

Composition of Grass and Silage (dried at 100° C.).

	Grass.	Ensilage.
Fat (ether extract)	2·80	5·38
Soluble albuminous compounds.	3·06	5·98
Insoluble albuminous compnds.	6·94	3·77
Mucilage, sugar and extractives, &c.	11·65	4·98
Digestible fibre	36·24	33·37
Indigestible woody fibre	32·33	31·79
	93·02	85·27
Soluble mineral matters	5·24	12·62
Insoluble mineral matters . ..	1·74	2·11
	100·00	100·00

The striking difference in the mineral matter of the grass and silage I will merely draw attention to; it is not due to the salt added to the silage. I may say, however, that other analysts and I myself have found similar striking differences. For instance, Professor Kinch* found in grass 8·50 per cent mineral matter, in silage 10·10 per cent, which, as he points out, is equivalent to a "loss of about 18 per cent of combustible constituents"—a loss which we have no proof of having taken place. In Mr. Smetham's sample the loss would have to be 50 per cent, which did not occur, and in fact is not possible. What is the explanation?

I am, however, considering now the organic constituents. Calculating the percentages of these in the grass and silage we obtain the following figures:—

Percentage Composition of Organic Compounds.

	Grass.			Ensilage.
Fat (ether extract)	3·01			6·31
Soluble albuminous compnds.	3·29	10·75	11·43	7·01
Insoluble ,, ,,	7·46			4·42
Mucilage, sugar and extrctvs.	12·52			5·84
Digestible fibre	38·96			39·14
Indigestible woody fibre . ..	34·76			37·28
	100·00			100·00

The difference in the total nitrogen in the grass and silage is equal to 0·68 per cent of albumenoids. Practically it is a matter of impossibility that the nitrogen could have increased in the silo, and it will be a very safe premise upon which to base any further calculations that the total amount of nitrogen in the silage was identical with that in the grass. There may have been a loss, but that is not yet proved. Arguing then upon the first hypothesis, it is evident that 100 parts of the organic matters of silage represent more than 100 parts of the organic matter of grass, and by the equation we obtain 10·75 : 11·43 :: 100 : 106 approximately. If now we calculate the composition of 106 parts organic matter of grass it will represent exactly the organic matter which has gone to form 100 parts of that present in silage.

The following table gives these results, and also the loss or gain in the various constituents arising from the conversion into silage.

* *Journ. Chem. Soc.*, March, 1884, p. 124.

Organic Matter.

	In 106 pts. Grass.	In 100 pts. Silage.	Loss or Gain.
Fat (ether extract)	3·19	6·31	+3·12
Soluble albuminous compnds.	3·49	7·01	+3·52
Insoluble ,, ,,	7·91	4·42	−3·49
Mucililage	13·27	5·84	−7·43
Digestible fibre.	41·30	39·14	−2·16
Indigestible woody fibre . ..	36·84	37·28	+0·44
	106·00	100·00	

These calculations show, provided my reasoning be correct, that the chief changes which take place are in the albuminous compounds, which has already been pointed out by Professors Voelcker, Kinch, and others; and in the starch, gum, mucilage, sugar, and those numerous bodies termed extractives, which was to be expected. But they show most conclusively that the "decrease in the amount of indigestible fibre and increase in digestible" so much spoken of is, so far as our present very imperfect methods of analysing these compounds permit us to judge, a myth; and I have not yet found any sufficient evidence to support this statement. A loss, then, of 6 parts of organic matter out of every 106 parts put into the silo has in this instance taken place, due chiefly to the decomposition of starch, sugar, and mucilage, &c. And as the grass contained 70 parts of water when put into the silo, the total loss would only be 1·7 per cent of the total weight. This theoretical deduction was found by practical experience correct, for Mr. Smith, agent to Lord Egerton, upon whose estate this silage was made, in his report to Mr. Jenkins, says the "actual weight out of the silo corresponds exactly with the weight we put into the same."

In my judgment these figures are of interest to the agricultural chemist for many reasons. Firstly, they will clear the ground for future workers and eliminate from their researches what would have greatly complicated them—changes in the cellulose bodies.

Secondly, they are of interest because our present methods of distinguishing between and estimating digestible and indigestible fibre is most rough, and probably inaccurate, and may not in the least represent the power of an animal—say a cow—to digest these various substances; and most of us know that when a new method of analysis becomes a necessity, a new method is generally discovered. Lastly, they are of interest to the agriculturist, for they point out, I believe for the first time, the exact amount of loss which grass—or at least one sample—has undergone in conversion into silage, and also that much of the nitrogenous matter is changed, and so far as we know at present, lost its nutritive value. This, however, is only comparing silage with grass. What is wanted is to compare silage with hay—both made out of the same grass. Then, and then only, will it be possible to sum up the relative advantages or disadvantages of the two methods of preserving grass as food for cattle.

Agricultural Laboratory,
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Society of Arts.—The last course of Cantor Lectures for the present session will be on "Fermentation and Distillation," by Prof. Noel Hartley, F.C.S. The course will consist of three lectures and will be given on Monday evenings, the 12th, 19th, and 26th instant.

A Case of Dimorphism observed with Sodium Hyposulphite.—F. Parmentier and L. Amat.—The authors have obtained crystals of this salt, of an unusual form, by cooling very concentrated solutions of this salt by means of a freezing mixture, in the absence of any particle of the ordinary crystal. The crystals thus produced agree in composition with the normal form, but they melt at 32° instead of at 49°.—*Comptes Rendus.*

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, May 1, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—H. B. Baker, E. J. B. Barlow, W. F. Fremersderff, J. Hargreaves, F. Nettlefold, J. Parr, A. E. Page, T. Stormouth, J. S. C. Wells.

The following papers were read:—

"*On Benzoyl-acetic Acid and some of its Derivatives*" (Part I.), by W. H. Perkin, Jun. For various reasons the author determined to carefully examine benzoyl-acetic ether with special reference to reactions in which the ketone group takes part. He describes first the preparation of phenyl-propiolic acid; 500 grms. of cinnamic acid are suspended in 1 to 1½ litres of absolute alcohol, and hydrochloric acid is passed until the whole is dissolved. After standing for 2 to 3 hours the product is poured into ice and water. The cinnamic ether separates out as an oil, which is dissolved in ether, washed with a dilute solution of sodium carbonate, and thoroughly dried and treated with 440 grms. of bromine. After standing for a short time the whole is poured into a large dish and the ether allowed to evaporate, when phenyl-dibromo-propionic ether separates out as a solid cake of large crystals. These are pressed between filter-paper and decomposed by alcoholic potash. The potassic phenyl-propiolate is finally treated with dilute sulphuric acid, when the free acid separates out as an oil. After purification it was obtained in crystals, the measurements of which are given. The acid was then converted into phenyl propiolic ether, which, when treated with ordinary sulphuric acid slightly diluted with water, forms benzoyl-acetic ether. Full details of all the reactions are given. The ether is a colourless oil boiling 265° to 270° without much decomposition; it gives the same violet colouration with chloride of iron as aceto-acetic ether; boiled with dilute sulphuric acid it splits up into aceto-phenone, alcohol. and carbonic anhydride. The hydrogen atoms in the CH_2 group are replaceable by sodium. The barium, silver, copper, and lead salts were prepared. When pure benzoyl acetic ether is treated with dilute aqueous potash, and the resulting product decomposed with dilute sulphuric acid, benzoyl-acetic acid was obtained, which, after purification, crystallised in thin transparent needles, which polarise light and melt 103° to 104°. The copper, lead, calcium, barium, and ferric salts were prepared, and two analyses are given of the pure acid. In the next part of the paper the author has prepared compounds in which the hydrogen atoms in the methylen group are substituted by ethyl, &c. Thus, ethyl-benzoyl-acetic acid, melting at 111° to 115°, and ethyl-benzoyl-acetic ether were investigated. The latter substance, when treated with moderately dilute potash, yields much phenyl-propyl-ketone, but with strong potash mostly organic acids are formed. The latter part of the paper gives an account of the preparation of diethyl-benzoyl-acetic acid, allyl benzoyl-acetic acid, the corresponding ethers, their decomposition products, and an investigation of the action of bromine on allyl-aceto-phenone.

Dr. Percy Frankland then read a paper "*On the Composition of Coal and Cannel Gas in Relation to their Illuminating Power.*" In this paper the author gives the results of his examination, somewhat in detail, of the gas supplied to some of the more important towns of the United Kingdom. The constituents which have been individually determined are the hydrocarbons absorbed by fuming sulphuric acid, carbonic anhydride, oxygen, nitrogen, hydrogen, carbonic oxide, and marsh-gas. In all cases the carbon density of the hydrocarbons has been determined, and in many cases also the hydrogen density; the carbon and hydrogen densities together representing the average molecular formula of the hydrocarbons present. Details of the determination of these densities are given, The reputed illuminating power and the ratio of the illuminating power to the proportion of ethylene to which the heavy hydrocarbons are equivalent, are also recorded. The predominant hydrocarbon seems to be ethylene, but the quantity of this gas present is quite insufficient to account for the illuminating power of the gas. So that the denser hydrocarbons, though present in comparatively insignificant proportions, have much to do with the actual illuminating power. In comparing these analyses with similar results obtained in 1851 and 1876, it is seen that the carbon density has diminished whilst the quantity of nitrogen has increased.

Dr. Armstrong said that in oil-gas much of the illuminating power was due to acetylene, crotonylene, &c., and probably in coal-gas the illuminating power was due to hydrocarbons of the acetylene series rather than to benzene. He suggested that the sulphur in coal-gas, other than hydrogen sulphide, might be due to the presence of thiophene.

The Secretary then read a paper on "*A New Form of Pyrometer,*" by T. Carnelly and T. Burton. The pyrometer which the authors have used since 1881 consists essentially of a copper coil which is placed in the muffle, kiln, &c., whose temperature is to be determined. Through this coil flows a constant current of water. The temperature of the water is taken as it enters the coil and as it flows out; from the difference of these two temperatures and a table the temperature to which the coil has been exposed can be ascertained. A similar instrument has been devised by Boulier (*Bull. Soc. Chim.*, 40, 108). By means of the above instrument temperatures up to 650° C. have been determined to within 25°.

The Secretary then read three papers by E. Divers and Masachika Shimosé of Tokio.

I. "*On Selenium Sulphoxide.*" The authors summarise their results as follows:—A yellow modification of selenium sulphoxide appears to exist, but has not been obtained pure. When heated, it is decomposed into selenium and sulphur trioxide; sulphur trioxide oxidises selenium sulphoxide, forming selenium dioxide and sulphur dioxide. Tellurium sulphoxide, when decomposed by water, gives tellurium and sulphuric acid, and by a secondary reaction sulphurous and tellurous acids are formed.

II. "*On the Reaction between Hydrogen Chloride and Selenium Sulphoxide.*" This reaction may be represented by the two equations—

$$(1)\ 2SeSO_3 + 2HCl = SeSO_3SeCl_2 + H_2SO_3$$

$$(2)\ \underbrace{SeSO_3SeCl_2}_{\text{Selenium Sulphoxychloride.}} + HCl = \underbrace{Se_2Cl_2}_{\text{Selenium Selenochloride.}} + SO_2HOCl$$

Selenium is dissolved in fuming sulphuric acid, and hydrochloric acid gas passed into the solution, which slowly deposits drops of a deep red liquid; this is the selenium seleno-chloride. The mother-liquor contains the sulphuryl-hydroxychloride, which has not yet been isolated.

III. *On Selenium Seleno-chloride.*—The properties, physical and chemical, and an analysis of this substance are given.

Dr. W. R. Hodgkinson then read a paper "*On Fluorene* (*Part* II.)." During the fractional distillation of fluorene the author noticed the formation of an orange-red substance. It appeared probable that this body might be an oxidation product. Several kilogrms. of fluorene, melting-point 100°, were slowly distilled, and the fraction between 280° and 295° crystallised from acetic acid and re-distilled. The fraction between 285° and 290° was then passed over a mixture of lead oxide and manganese oxide (5 to 1) in a wide iron tube heated to the temperature of melting tin. A red solid thus distilled over, but the coloured substance could not be separated from the unchanged hydrocarbons by distillation. A partial separation was effected by boiling the substance twenty or thirty times with 50 per cent acetic acid, which dissolved out the fluorene. The substance thus obtained crystallised

from glacial acetic acid in rhombs, m.p. 165° to 170°, subliming with partial decomposition, and forming a dense red vapour. The body was oxidised by a solution of chromic anhydride in glacial acetic acid. Two oxidation products were obtained, one crystallising in pale yellow needles, almost insoluble in cold chloroform, melting at 278°, and the other separating in short red needles melting at 188°, both having the composition $C_{13}H_8O_2$. The author has not succeeded in isolating the red colouring substance: it appears to decompose on distillation even in a vacuum, and is equally soluble with the hydrocarbons it accompanies in the different solvents.

The Society then adjourned to May 15th.

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, April 26, 1884.

Prof. F. Guthrie, President, in the Chair.

New Members:—Mr. Chattock, Mr. Inwards.

Profs. Perry and Ayrton read a paper on the "*Indicator Diagram of a Gas-Engine*," which was intended to teach to practical engineers a method of studying gas-engine diagrams. The most recent results obtained by the use of Dowson gas were stated, and it was suggested that before long gas-engines will be employed for the propulsion of ships. A large wooden model of an Otto gas-engine enabled the operations going on during a cycle of the engine to be understood. Tables were given of the constituents of coal-gas and Dowson gas, the air required for combustion, the heat of combustion, and the specific heats, to enable the characteristic equation of the fluid used in the gas-engine to be determined. An easy method of obtaining one empirical formula to represent all the diagrams which can be obtained from an engine with different quantities of gas was described, and its results compared with observation. The effects of vibration of the indicator spring in the various parts of the diagram were discussed, as well as the effect of the last explosion; which are provided for in the empirical formula. Three practical methods of determining the rate q of gain of heat by the fluid during the forward stroke were given, and a diagram was shown in which this rate could everywhere be compared with the rate of doing work. If w is the indicated work in one cycle, it was shown that $5{\cdot}64\,w$ is the total energy of combustion of one charge, and this is expended as follows:—$1{\cdot}45\,w$ is the work done in the forward stroke; $2{\cdot}22\,w$ is given to the cylinder by radiation in the forward stroke; $1{\cdot}5\,w$ is carried off though the exhaust pipe; $0{\cdot}47\,w$ is given to the cylinder as heat after exhaust valve opens. The rate at which the loss, $2{\cdot}22\,w$, by radiation occurs at every point of the forward stroke was shown on a diagram obtained from a knowledge of the temperature at every point in the stroke, and when the ordinates of this diagram were added to the q diagram previously described—a diagram was obtained showing at every point of the stroke the rate at which combination was going on. This diagram was especially important as showing the effect of dissociation in the gas engine.

Dr. W. H. Stone exhibited a simple form of syphon mercurial barometer with metrical scale. Two millimetre scales are adjusted to slide easily side by side; the lower edge of one is brought on a level with the mercury in the shorter limb, and the other slid up and down until its lower edge coincides with the upper mercury surface. The adjustment is easily effected by an observer without stooping by the use of two right-angled glass prisms fitting on the upper and lower ends of a vertical glass-tube.

The next meeting of the Society, on May 10, will be held in the Mason College, Birmingham.

Correction.—In the "Note on the Employment of the Abel Petroleum Testing Apparatus in Tropical Climates," at p. 196, the joint author with Sir Frederick Abel was Mr. Boverton Redwood (not Kidwood).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 12, March 24, 1884.

Separations of Gallium.—Lecoq de Boisbaudran.—This paper will be inserted in full.

On a Probable Cause of Discrepancy between the Electromotive Force of Batteries and Thermo-chemical Data.—G. Chaperon.—The author refers to the fact that an element composed of aluminium, dilute sulphuric acid, sulphate of copper, and copper gives only 0·62 volt, whilst its theoretic electromotive force is 2·06 volts. A magnesium-platinum element in potassa, contrary to what thermic data indicate, is less energetic than a zinc-platinum element in the same liquid. Although the phenomenon known as polarisation is not generally considered as capable of modifying the electrical energy furnished by a chemical action otherwise than by the fact of the passage of the current, it seems possible that the inherent properties of the metals which concur in producing this phenomenon may also modify the static electromotive force. The author has therefore verified the phenomena of polarisation produced by the metals in question in the solutions where the electric energy which they produce presents anomalies.

On Sodium Sulphites and Bisulphites.—M. de Forcrand. Of these salts the metasulphite (anhydrous bisulphite) is the only one which is permanent in solution.

Zeitschrift für Analytische Chemie. Vol. xxii., Part 4, 1883.

Determination of Volatile Organic Compounds of Chlorine.—M. Berthelot.—The author withdraws such compounds from solution by means of a current of air and watery vapour, and conducts this mixture through a red-hot tube, or causes it to be traversed by a brisk current of electric sparks. The gases are then passed through a solution of silver nitrate when a precipitate of silver chloride is formed, if chlorine was originally present. To prevent confusion with silver cyanide or acetylenide the gases after ignition may be passed into a large quantity of water, which is boiled for some time, so that hydrocynic acid and acetylene escape.

Sauer's Method of Determining Sulphur.—W. T. Mixter.—From the Chemical News.

Determination of Sugar by Clerget's Method.—J. H. Tucker and P. Casamajor.—From the Chemical News.

Determination of Sugar by Means of Polarised Light.—E. Lebaigne.—From the *Moniteur Scientifique.*

Determination of Dextrose, Maltose, and Dextrine in Starch Sugar.—H. W. Wiley.—From the Chemical News.

Elemementary Composition and Quantitative Determination of Rice Starch.—F. Salomon.—The author is of opinion that rice and potato starch are quite alike in composition, but that the former, though entirely dissolved when heated with dilute acids, is not completely transformed into glucose, but in part into compounds which do not reduce Fehling's solution.

Determination of Tannin.—F. Simand.—This important memoir will be inserted as fully as possible.

Preparation of Soap-Solution for Water Analysis.—C. R. C. Tichborne.—From the *Analyst.*

Determination of Hardness in Water.—H. W. Langbeck.—From the Chemical News.

Examination of Milk.—L. Janke.—The results obtained by desiccation are accurate and constant without the use of sand.

Analysis of Milk.—P. Vieth and O. Hehner.—From the *Analyst*.

Detection of Alum in Bread and Flour.—A. Wynter Blyth.—From the *Analyst*.

Determination of Coke and Volatile Matter in Coal.—R. Galloway.—From the *Engineering and Mining Journal*.

Titration of Alkaline Ferrocyanides with Copper Sulphate (Hurter's method)—G. Lunge.—The results are inaccurate. It is better to mix a sample with bromine-water from a burette until it no longer turns blue with ferric chloride. A second portion is then mixed with the calculated quantity of the oxidising agent and titrated with copper sulphate until a drop gives a distinct rose colouration with solution of ferrous sulphate. This process yields, however, only 79 to 85 per cent of the values obtained by precipitation as prussian blue, conversion into sodium ferrocyanide, and titration with permagnanate. Lunge considers the method sufficiently accurate as a check on the black-ash lyes.

Iron Analysis.—The colorimetric method for the determination of manganese proposed some time ago by Pichard is applied, according to Goertz, for the daily determinations of manganese in cast-steel at the iron-works of Ohio. The process is thus described by A. Ledebur:—There are required some stand burettes, about 12 m m. in diameter, containing 30 c.c. graduated in tenths of c.c.'s, beginning from below. The author uses the same burettes as for the colorimetric carbon test; a normal solution of manganese, prepared by dissolving 0·0718 grm. crystalline permanganate in 500 c.c. water. One c.c. of this solution contains 0·00005 grm. of manganese. Of the iron or steel in question there are dissolved exactly 0·2 grm. in a flask with a mark at 100 c.c. The solution is effected by means of 10 to 15 c.c. of ordinary nitric acid with the aid of heat; the solution is let cool, distilled water is added up to the mark, and the whole is mixed by shaking. Of this solution 10 c.c. are put in a 60 c.c. beaker along with 2 c.c. nitric acid and heated to incipient boiling. The flame is withdrawn, and peroxide of lead is added in excess, well shaken, heated for a short time, and when cold the liquid is filtered through an asbestos filter into one of the burettes. The filter is washed with cold water. In a second burette there is put, according as the red colour of the solution appears lighter or darker, 1 to 4 c.c of the normal solution of manganese, which is then cautiously diluted with water until both solutions when held against a sheet of white paper display the same tone of colour. If a denotes the number of c.c. of the normal solution taken, and b the number of c.c. to which the a c.c. have to be diluted, and d the number of c.c. of the iron-solution, the proportion of magnanese in the iron solution is then $\frac{a}{b}\, d + 0{\cdot}25$ per cent. If the proportion of manganese is very small, two or three times the quantity of iron may be taken. The method is most suitable for irons which do not contain much more than 2 per cent of manganese.

Colorimetric Determination of Carbon in Steel according to the Method of Eggertz.—The reader is referred to "Wagner's Report on Chemical Technology."

Sources of Error in the Determination of Iron in Ores by the Stannous Chloride Process.—K. F. Föhr.—The principal of these are the volatilisation of ferric chlorides when the ores are dissolved in fuming hydrochloric acid; the presence of pyrolusite in many iron ores by which chlorine is liberated.

Titration of Zinc with Sodium Sulphide.—M. Schrœder.—The author recommends thallium paper as an indicator in place of lead—or cobalt paper. To prepare this paper 1 grm. thallium is dissolved in nitric acid; the excess of acid is expelled in the water-bath and the residue is dissolved in 500 c.c. water. Filter-paper is soaked in this solution. The spots produced by sodium sulphide are brown and are very easily perceptible. The following three conditions must be kept in mind:—In the zinc solution there should be a large and approximately equal proportion of ammonium chloride, a slight but also approximately equal excess of free ammonia, and the zinc solution of known value used for standardising must have the same proportion of sal-ammoniac and ammonia as the liquid to be analysed.

The Detection of Colours fixed on Tissues and fibres.—Jules Joffre.—Already inserted at length.

Valuation of Sulphocarbonates.—O. Hehner and H. S. Carpenter.—From the *Analyst*.

Detection of Cotton Oil in Olive Oil.—S. S. Bradford.—The author mixes the oil in question with a solution of basic lead acetate and lets it stand for 12 to 24 hours. If cotton oil is present it takes a red colour like fresh prepared tincture of myrrh.

Analysis of Fats.—F. Reinitzer.—Barium oleate can only be dried in a vacuum over sulphuric acid; at 100° it loses oleic acid even at the ordinary atmospheric pressure. Barium stearate can be easily dried at 100°. In preparing the ammonium salts of the fatty acids an excess of ammonia must always be present to prevent the formation of an acid salt.

On Bees'-Wax.—E. Zatzeck.—The author contests the statement of Schalfeef that Brodie's cerotic acid can be split up into several acids by fractionated precipitation with lead acetate.

The Analysis of Phosphates.—H. v. Ollech and B. Tollens.—The substance of this paper has been already inserted.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Prussian Blue.—Can any correspondent inform me what demand there is for this substance in the arts, and for what purposes it is principally used? Would a production of 20 to 40 tons per week completely swamp the market?—P. B.

The Degree of Ph.D.—Could you inform me where and how the degree of "Ph.D." is obtained? I am a student of chemistry, and as I have observed that many lecturers on chemistry have this title, I should much like to know where it is to be got.—G. F. E.

Commercial Carbonate of Ammonia.—(Reply to "Ammonia.")—See "Bloxam's Chemistry," 3rd edition, p. 121, for hydrochlorate of ammonia. Sublime a mixture of one part thereof with two parts of chalk in an earthen or iron retort, with receiver of earthenware or lead. Carbonate of ammonia distils over in the liquid form, and solidifies in the receiver.—G. A. Keyworth.

MEETINGS FOR THE WEEK

Monday, 12th.—Society of Arts, 8. "Fermentation and Distillation," by Prof. W. Noel Hartley.
Tuesday, 13th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.
— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.
Wednesday, 14th.—Society of Arts, 8. "Telpherage," by Professor Fleeming Jenkin.
— Geological, 8.
— Microscopical, 8.
Thursday, 15th.—Royal, 4.30.
— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
— Chemical, 8. "On the Indices of Refraction of Organic Substances," by Dr. J. H. Gladstone. "Some Minor Researches on the Action of Ferrous Sulphate on Plant Life," by A. B. Griffiths.
Friday, 16th.—Royal Institution, 8. "The Dissolved Oxygen of Water," by Prof. Odling, at 9.
Saturday, 17th.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.

THE CHEMICAL NEWS.

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SOME NEW PHENOMENA OF ELECTROLYSIS.*

By G. GORE, F.R.S., LL.D.

WHILST making a series of experiments on the "self-deposition of metals," I observed, by trying a number of different metals, that several of them received an electrolytic deposit of cadmium by contact with cadmium in various solutions of that metal much more frequently than others; I therefore made various experiments to determine whether this was due to difference of density of current or to other causes.

By means of these additional trials I found, on passing an undivided current through a series of portions of the same metallic solution, that cathodes composed of different metals of equal amounts of immersed surface, required currents of different degrees of density to cause deposits of the same metal upon them, and that the differences in some cases were considerable. Another singular circumstance was also observed, viz., that the cathode which most readily received a deposit was frequently the one composed of the same kind of metal as that which was being deposited. I am now examining these new facts.

INFLUENCE OF CHANGE OF CONDITION FROM THE LIQUID TO THE SOLID STATE ON VAPOUR-PRESSURE.†

By Prof. WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc., Lecturer and Demonstrator of Chemistry in University College, Bristol.

THE object of this Paper is to furnish experimental proof of the theory advanced by Prof. James Thomson (*Brit. Assoc. Reports*, 1871 and 1872, and *Proc. Roy. Soc.*, vol. xxii., p. 27), that the pressure exerted by the vapour of a solid substance at a given temperature is less than that of the vapour of the substance in the liquid form at the same temperature.

This relation was specially sought for by Regnault, and, as shown by Prof. Thomson, he unwittingly furnished a proof for it in the formulæ devised by him to express the vapour-pressures of ice and of water. Regnault himself, however, from the results of numerous experiments, came to an opposite conclusion, and this conclusion is as yet generally accepted.

A graphic representation of the results obtained by us on heating camphor in a barometer-tube to temperatures ranging from about 150° to 200° shows (1) considerable irregularity about the melting-point, and (2) that a prolongation of the portion of the curve representing relation of pressure to temperature above the melting-point would intersect the portion below the melting-point.

With benzene, also, the vapour-pressures of which were determined by the method described by us in a paper shortly to appear in the *Transactions* of the Society, the solid gas curve is evidently not continuous with the liquid gas curve.

Employing the same apparatus, acetic acid was successfully cooled to temperatures far below its freezing-point without solidification, and numerous extremely concordant observations of the vapour-pressures both of the liquid and of the solid acid were obtained. These observations represented graphically form two widely-divergent curves, which intersect in the neighbourhood of the melting-point of the solid acid, 16·4°.

The barometric method was next employed; but the results, like those obtained by Regnault, were capricious. That this capriciousness was not attributable to the presence of air was proved by special experiments, and it remains unaccounted for.

Several very careful determinations of the vapour-pressures of ice and of water below the freezing-point were made. A comparative method was first employed, in which ice and water cooled below its freezing-point were simultaneously subjected to the same pressure, which could be varied at will, and the differences of temperature noted.

Another series of observations had reference to the vapour-pressures of ice alone, at temperatures ranging from 0° to −16°. The numbers obtained, when represented graphically, proved not to be identical with those calculated by means of Regnault's formulæ D and E: accepting formula D, which represents the vapour-pressures of steam in contact with water, as correct, owing to the greater number of observations and the greater range of temperature over which they extend, the ice-steam curve was re-calculated by the method given by Professor James Thomson, and it was found that our observations agreed much more closely with this curve than with that deduced from Regnault's formula E.

In the original paper, figures and diagrams illustrating these points are given.

As these substances—camphor, benzene, acetic acid, and water—are representatives of very different chemical types, it may be held to be true for all stable substances that the vapour-pressure of the solid is less than that of the liquid at the same temperature, and that the differences between these pressures are calculable from thermic data, where these are known.

In conclusion, attention is drawn to the new method of ascertaining the vapour-pressures of solids and liquids, and a full statement of the important advantages which it offers is given.

ANTISEPTIC EXPERIMENTS IN A MORTUARY VAULT.*

By C. A. CAMERON, M.D., F.R.C.S.I., Vice-President Institute of Chemistry of Great Britain and Ireland.

IN the vaults of the ancient Church of St. Michan, Dublin, the bodies deposited become desiccated and, so to speak, mummified. The muscles present the appearance of adipocere, and the ligaments resemble old leather thongs. The vaults are situated at no great distance from the surface of the ground. They are built of limestone, and the soil beneath consists of gravel of an argillaceous limestone locally termed calp. The author did not consider that any of the asserted or assumed causes of the antiseptic properties of the vaults had been proved; but he considered that they might in part be due to their remarkable dryness and the freedom of their atmosphere from dust. He made some experiments in one of the vaults with the view of ascertaining whether or not unstable organic infusions would soon ferment in them. A large number of Tyndall's tubes were charged with an infusion of melon containing 0·84 per cent of solid matter. The infusion was sterilised by exposing them for half an hour to a temperature of 300° in a paraffin bath. The tubes were kept for a week in the laboratory, at the expiration of which time the contents of two of them had become turbid and opaque. On the seventh day, four of the tubes (all of which had been sealed by the gas blowpipe) were opened, and in the course of a week their contents had become mucilaginous. The remaining twelve tubes were next

* A Paper read before the Royal Society, May 1, 1884.
† Abstract of a Paper read before the Royal Society, April 24th, 1884.

* Abstract of a Paper read before the Academy of Medicine in Ireland, April 10, 1884.

deposited in one of the vaults of St. Michan's Church, the most elaborate precautions having been adopted to allow the atmosphere in it to be quiescent before the necks of ten of the tubes had been nipped by a highly heated pincers. The vault was kept locked for six weeks, and on the 13th August, 1879, it was entered, and the tubes removed. It was found that the contents of five of the tubes had become filled with mycelium, and that the contents of the remaining seven tubes were perfectly bright and transparent. Two of these seven tubes had remained sealed. In a few days the contents of the seven tubes, to which the air of the laboratory had now access, became so thick that they could not be poured out of the tubes. The author does not venture to draw any positive conclusion from these results, but he inclines to the opinion that the contents of the five open tubes which remained clear had not fermented, owing to the air which was in contact with them being free from dust containing ova germs, &c. In the case of the five tubes, the contents of which had become decomposed, dust had of course found its way into them. It was, however, interesting to record that for six weeks in hot weather an unstable organic liquid remained undecomposed in this vault.

THE HEAT OF HYDRATION OF SALTS.

By SPENCER UMFREVILLE PICKERING, M.A.

THE heat of hydration of an anhydrous salt is assumed (Graham, *Phil. Mag.*, 1843; Thomsen, *Journ. für Prakt. Chem.*, xviii., 5) to be given by taking the algebraic difference between the heat of solution of the anhydrous salt (A) and that of the hydrated salt (B). This difference (A – B) gives, it is true, the heat produced by the absorption of a certain number of molecules of water by the anhydrous salt, but it does not represent the energy of the chemical combination of the water with the anhydrous salt; for, in addition to the heat developed in this combination, the term A – B includes the heat evolved by the conversion of a certain amount of liquid water into solid water, Persoz's researches on specific heats having shown that the water of crystallisation of a solid hydrated salt is in the condition of solid and not liquid water.

Taking the instance of magnesium sulphate and the numbers given by Thomsen—

$$MgSO_4 \quad + aq \text{ liberates } 20280 \text{ cals.}$$
$$MgSO_4,7H_2O + aq \quad ,, \quad -3800 \quad ,,$$

Whence he deduces that $MgSO_4 + 7H_2O = 24080$ cals., whereas in reality 10010 cals. of this is due to the solidification of the $7H_2O$, leaving for the chemical action represented by $MgSO_4 + 7H_2O$ only 14070 cals. Similar corrections should be made in other cases.

DETERMINATION OF PHOSPHORIC ACID IN ARABLE SOILS AND ROCKS.

By M. AD. CARNOT.

THE author treats 20, 25, or sometimes even 50 grms. of earth, from the soil or subsoil, at first with dilute hydrochloric acid until effervescence has ceased, and then with aqua-regia at a boiling heat. The solution obtained is diluted and filtered. It is generally coloured yellow by ferric chloride, and contains often alumina enough for the completion of the process; however, as a rule applicable in all cases, it is recommended to add 0·2 to 0·3 grm. alumina in the form of hydrochlorate.

The greater part of the acid is neutralised with ammonia, and sodium carbonate is then added until a slight change of tint occurs in the cold liquid, which, however, should remain quite limpid. A dilute solution of sodium hyposulphite is then added, and mixed rapidly by stirring, when the liquid turns first to a violet, and then becomes colourless. At this moment there is added a solution of a mixture of sodium hyposulphite and acetate (about 5 grms. of each), and the mixture is heated to a boil, and kept at this point for a quarter of an hour. The precipitate of alumina and sulphur is filtered, and washed with boiling water, so as entirely to remove the salts of iron.

M. Chancel has long ago pointed out the possibility of separating alumina from ferric oxide by means of sodium hyposulphite. The author finds that by proceeding as above the same result may be obtained in presence of phosphates. The alumina is thrown down free from iron, and carries with it all the phosphoric acid. It appears in a form much less gelatinous than when precipitated with ammonia, and can be quickly washed with hot water.

The precipitate is dried, and ignited in a small porcelain capsule, which should be kept covered at first, to prevent as far as possible the formation of sulphuric acid during the combustion of the sulphur. The phosphoric acid is certain to be found in the tribasic state in the ignited product. It is re-dissolved in a few c.c. of nitric acid, heated so as to expel the greater part of the acid, diluted with water, filtered and received into another porcelain capsule, in which it ought to occupy a volume of about 30 c.c. There is then poured into it a solution of molybdic mixture, prepared according to known rules, and it is left for twenty-four hours at a moderate temperature. It is decanted, and washed with the same reagent, observing if the liquid, on standing for a second day, leaves any further deposit.

If the yellow phospho-molybdic deposit is very slight, it may be received at once upon a tared filter, washed with alcohol, dried, weighed, and taken as containing 3·6 per cent of phosphoric acid. But care should be taken to place by the side of the capsule a similar one containing molybdic mixture and nitric acid at the same degree of dilution, in order to prove that no deposit occurs in the same time.

If, on the other hand, the yellow deposit is considerable, it is re-dissolved in a little ammonia, precipitated with magnesia mixture, and finally weighed as magnesium pyrophosphate, containing 64 per cent of phosphoric acid.—*Comptes Rendus.*

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Boric Acid.

THE author finds only the two following methods for the simultaneous determination of gallium and boric acid. The difficulty springs from the paucity of stable compounds in which boric acid can be determined.

1. From a very acid hydrochloric solution the gallium is precipitated by a slight excess of potassium ferrocyanide. To the filtrate is added a slight excess of cuprous chloride, which forms a brown precipitate of copper ferrocyanide. This is filtered off, and washed with water acidulated with hydrochloric acid. From the clear liquid the copper is removed by means of sulphuretted hydrogen gas. The liquid is then placed in the cold, under a bell-glass over a vessel containing caustic potassa. After it has been reduced to a small volume calcium chloride is added, it is supersaturated with ammonia, and evaporated to dryness by means of a moderate heat.

The determination of the boric acid is then effected by M. Ditte's method (*Comptes Rendus*, Feb., 1875, p. 490), *i.e.*, by covering the matter with a sufficient quantity of potassium and sodium chlorides taken in equal equivalents, fusing the whole at a red heat, and causing the calcium borate to crystallise by distributing the heat in a suitable manner upon the sides of the crucible. In this manner

we may either separate a small quantity of gallium mixed with much boric acid, or a little boric acid mixed with much gallium.

The calcium borate obtained at the end of the analysis is often mixed with a little ferric oxide; it is then re-dissolved in hydrochloric acid, supersaturated with potassium and sodium carbonates (or hydroxides) in equal equivalents, and ignited. The mass, on treatment with water, deposits iron oxide, whilst the boric acid remains in the alkaline liquid. The latter, after being slightly supersaturated with hydrochloric acid, is again treated according to Ditte's method.

2. The hydrochloric solution, slightly acid, is mixed with an excess of acid, potassium, and sodium acetates in equal equivalents, and a suitable quantity of arsenious acid. A current of sulphuretted hydrogen gas precipitates arsenic sulphide, which carries down with it the gallium. Air is forced through the filtrate in order to expel the greater portion of the hydrogen sulphide, and the liquid is then supersaturated with excess of a mixture of potassium and sodium hydroxides in equal equivalents. The mass is placed in a vessel of gold, evaporated to dryness, and finally ignited with access of air. It is dissolved in water, slightly acidified with hydrochloric acid, and M. Ditte's process is applied.

This method is especially advantageous for determining small quantities of gallium mixed with large proportions of boric acid.

The author has ascertained that an aqueous, or even hydrochloric, solution of boric acid loses no appreciable trace if evaporated in a vacuum at the ordinary temperature.—*Comptes Rendus*.

NOTES ON THE VOLUMETRIC ESTIMATION OF IRON.

By R. W. ATKINSON, B.Sc. Lond., F.C.S., F.I.C.

In my last communication I pointed out that in the volumetric estimation of iron great care has to be taken in choosing the method of standardising the solution of dichromate of potassium, without which care very considerable errors may be introduced into the analysis. In the present note I wish to make some observations upon the process of titration, presuming that the strength of the dichromate solution in terms of iron is accurately known.

A fair sample of the ore having been ground sufficiently fine to pass completely through a sieve of 120 meshes to the linear inch, part of it is dried at 100° C., and when cold portions of about 0·5 or 0·6 grm. are weighed out for analysis. Unless the balance is very rapid in its action it will be found necessary to re-dry the portions first weighed out, if accurate and concordant results are to be expected. The ore is in such a very fine state of division that it greedily absorbs moisture from the air during the operation of weighing out: this applies most forcibly to the soft red ores, like Campanil and Vena Dulce, but is also true of the harder Rubio and other brown ores. The weight of the portion being accurately known, it is transferred to a conical flask, and digested at a gentle heat on a hot plate with from 10 c.c. to 15 c.c. strong hydrochloric acid, the flask being closed with a watch-glass.

It has been asserted by K. F. Föhr (*Zeitschrift*, vol. xxii., p. 609) that ferric chloride is volatile at about 100° C., but this is contrary to all my experience of the matter. It is true that yellow drops of ferric chloride may sometimes be seen depending from the under surface of the watch-glass, but this is only the case when the solution is accompanied by a boiling of the liquid, and is doubtless due to spurting. If the digestion is carried on so as to avoid bubbling, the drops on the cover are always colourless, and no loss of iron from volatilisation need be feared.

When the ore has been completely dissolved the next step is the reduction from the ferric to the ferrous state, to effect which there are three reducing agents mainly employed,—viz., zinc, stannous chloride, and sulphurous acid in the form of one of its salts. I will deal with these in the order given.

Reduction by means of zinc is capable of giving trustworthy results, provided that pure zinc free from iron is employed; or if the zinc contains iron, provided that the amount thus introduced be allowed for. But the use of zinc is open to other objections: in the first place it dissolves only slowly, and thus unduly retards the operation, which, when a number of analyses are to be carried out, is a matter of no small moment. In the second place the titration is further retarded by the slowness with which the blue colour with potassic ferricyanide is developed in consequence of the presence of zinc chloride in the solution. And lastly, the colour towards the end of the titration becomes so faint, even when fully developed, that it is impossible to distinguish the presence of an amount of iron less than one- or two-tenths per cent of the iron contained in the ore. Consequently, although reduction by means of zinc permits the analyst to obtain uniformly concordant results without the risk of error, its action is too slow and its indications are not sufficiently delicate for the most accurate work.

But however much rapidity of work may be an object to be kept in view, there can be no doubt but that reduction by zinc is greatly to be preferred to the second method, viz., reduction by means of stannous chloride. Indeed I have no hesitation in saying that the latter method, as usually performed, is open to the grossest abuses, and ought to be prohibited by any authority which may seek to reform the present methods of analysis. I will justify these remarks presently, after I have described the usual manner of carrying out the process of reduction by this reagent.

A strongly acid solution of stannous chloride is used, often of a strength roughly corresponding with that of the potassic dichromate solution. Sometimes precautions are taken to prevent oxidation by preserving it under an atmosphere of nitrogen or carbonic acid; sometimes it is merely kept in a stoppered bottle, and portions taken out with a pipette.

The portion of ore having been dissolved in hydrochloric acid, in the conical flask, boiling water is added so as to about half-fill the flask, and the liquid is kept boiling during the addition of the stannous chloride, which is added to the boiling solution until the yellow colour of the ferric chloride has disappeared, showing that an excess of the reducing agent has been employed. In order to destroy this excess an oxidising solution is cautiously added until a drop of the liquid gives a faint red colouration when brought into contact with a solution of potassic sulphocyanide on a porcelain slab. When the operator is satisfied with the reduction, the addition of the standard dichromate solution is proceeded with in the usual manner.

It will be quite evident that the accuracy of the determination of iron in the sample is dependent upon the exactness with which the oxidising solution (potassic chlorate or dichromate) is added to destroy the excess of stannous chloride present, and that it is therefore possible to get too high or too low a result at will merely by adding too little or too much of the oxidising solution. In this way an unscrupulous chemist may produce a result which will harmonise with the interests of his client, and because this method opens the way to dishonest dealing do I justify my remark that it ought to be absolutely prohibited. But apart from cases of actual dishonesty, which no doubt are exceptional, it ought to be the determination of all those who wish to earn a reputation for accuracy to abandon a process of which it can be said that its results can be made variable at will—which can be made to give

either high results to suit the seller or low results to suit the buyer. I am far from saying that analysts consciously take advantage of this power. Most are doubtless influenced quite unconsciously—not wishing to leave any stannous chloride undestroyed, some perhaps add a little too much of the oxidising agent; others may have a weak perception of red rays, so that before they are able to see the red colour produced by contact with potassic sulphocyanide an excess of the oxidising agent has been added. In this way a permanent, unconscious bias towards low results may exist. In a similar way another chemist may be afraid of adding too much of the oxidising agent, and, as the mixture of ferrous chloride, stannous chloride, and potassic sulphocyanide oxidises very readily, he may observe a red tinge, whilst there is still an excess of stannous chloride in the solution, thus finding too high results.* In fact it is easy enough to get results which are too high or too low, but with stannous chloride as a reducing agent it is a matter of the greatest difficulty to get accurate results.

One reason why stannous chloride has become a favourite reducing agent is the rapidity with which the analysis can be made:—Starting with a tin of ore the percentage of moisture and iron in the ore can be found by this method (with the above qualification as to accuracy) in from two to three hours; but I hold that it is contrary to the best interests of a chemist to seek rapidity of work at the expense of accuracy, and I therefore strongly recommend the abandonment of this method of reduction.

Of all methods reduction of the ferric salt by the use of a concentrated solution of ammonic bisulphite is the most accurate and trustworthy. Sodic bisulphite is sometimes used, but is not nearly so satisfactory as the ammonic salt, as it is more difficult to separate the last traces of sulphurous acid from the former than from the latter. The mode of manipulation is as follows:—The ore having been dissolved in hydrochloric acid in the conicals, the solution is diluted with acidified water and filtered into pear-shaped flasks, the filters being thoroughly washed with hot acid water. The filtered ferric chloride is next carefully neutralised with ammonia, strong at first and afterwards dilute, until a faint reddish precipitate remains permanent. Two or three drops of strong hydrochloric acid are washed round the inner neck of the flask, and as the acid flows down it spreads out, dissolving any particles of ferric hydrate which may have remained on the sides of the flask. When the solution is quite clear, and of a faint reddish colour, 5 c.c. or 6 c.c. of a strong solution of ammonic bisulphite (sp. gr. 1·06) are added, the flask shaken, and boiling water added. On shaking the flask the colour entirely disappears, and the flask is then put over a burner. A small piece of thick platinum wire is introduced to assist the boiling, and about 15 c.c. or 20 c.c. of dilute sulphuric acid (1 acid to 6 water) are added to acidify the solution and to assist in the expulsion of the excess of sulphurous acid. After the liquid is once in a state of ebullition it is kept boiling briskly for thirty minutes (less time is sufficient, but it is always well to err on the safe side), during which time nearly the required amount of dichromate is run out into the dish. At the end of the half-hour the boiled solution is added to the potassic dichromate, and the titration is carried out as usual.

By proceeding as above there is only one loophole for the introduction of error, viz., in the length of time allowed for boiling off the sulphurous acid; but if the conditions as given above are fulfilled, constant and accurate results may be relied upon. The above method has this advantage, viz., that the solution is practically one of ammonio-ferrous sulphate, a salt which is one of the most stable of all the ferrous salts. It is therefore less liable to become oxidised by exposure to the air in transferring to the basin than the acid solution of ferrous chloride obtained by the two previous modes of reduction. A further advantage lies in the fact that the end reaction with potassic ferricyanide is beautifully clear and delicate, so that there is no difficulty in distinguishing the addition of 1-20th c.c. of dichromate (strength 1 c.c. = 0·005 grm. iron), equivalent to 0·00025 grm. Fe. Numerous experiments have shown that perfectly constant results can be obtained by this method, the same percentages of iron in a given ore having been found with different standard dichromate solutions (standardised as described in my first note) after the lapse of several months. It is rarely the case that three experiments carried out simultaneously give percentages of iron differing by more than 0·05 to 0·07 per cent of the ore, but the main advantage which the method of reduction by ammonic bisulphite possesses is that results are found which are perfectly independent of any unconscious bias on the part of the operator, and I feel convinced that were this method constantly and generally used we should hear less of differences of 2 per cent and 3 per cent between two chemists' analyses of the same sample of ore. The existence of "sellers" and "buyers" chemists is a disgrace to the profession, and anything which is likely to put an end to the scandal, even in one trade, ought to be welcomed.

One other point in the volumetric estimation of iron remains to be noticed. The solution of potassic ferricyanide slowly decomposes when the bottle containing it is exposed to diffused daylight and a yellowish sediment is deposited. This change is very greatly retarded, if not entirely prevented, by protecting the solution from light by covering the bottle with an inverted tin canister. Connected with this decomposition of the ferricyanide solution is the fact, already well known, that when a mixture of that solution with one of ferric chloride is exposed to daylight reduction takes place, and the solution turns blue. But it is not so generally known how rapidly this takes place, and that if the drops of ferricyanide to which the completely oxidised iron solution has been added be allowed to remain exposed to the light (protected from dust by means of a glass plate) for ten or fifteen minutes, a distinct blue tinge will be developed. It is important to remember this, for, in titrating, the blue colour requires two or three minutes to become fully developed when the amount of ferrous salt remaining in the solution is very small, and in order to prevent the drop turning blue by reduction under the influence of daylight, it is advisable to keep the slab covered with a black cloth or with a flat tin cover. By this means it is possible so to protect the mixture from change that no blueness is perceptible after the lapse of an hour or more, provided that all the iron in the solution to be titrated has been fully oxidised.

44, Loudoun Square, Cardiff.

* If an excess of stannous chloride be added to the iron solution, and afterwards an oxidising agent in insufficient amount to completely destroy the excess, a red colour will be observed on bringing a drop of the solution into contact with a drop of potassic sulphocyanide, which colour slowly disappears. It would thus seem that the ferrous salt is first oxidised, and that the excess of stannous chloride only slowly reduces it. In this way a very serious error may be quite unconsciously introduced. To avoid this I have attempted to neutralise the effect of the excess by the addition of mercuric chloride, in which I find that I have been anticipated by Dr. F. Kessler (*Zeitschrift*, xi., 249); but in my hands this method has given results almost as unreliable as are obtained by the use of other oxidising agents, though I am not able at present to assign a reason for its imperfect action. I may be able to explain it later.

Modifications of Gmelin's Test for Biliary Colours.—Capranica recommends the use of a 5 per cent solution of bromine, of chloric and iodic acid. These reagent are applied to the colouring matters, not in an aqueous, but in an alcoholic, ethereal or chloroformic solution. As the most sensitive procedure Capranica adds solution of bromine until the green colour appears, and then hydrochloric acid. On shaking, the green colour passes entirely into the hydrochloric acid. One part of bile pigment can thus be detected in 200,000. A. A. Krehbiel mixes 4 parts of the urine of a person afflicted with jaundice with 1 part hydrochloric acid and adds a saturated solution of chloride of lime, drop by drop. The characteristic colour is produced by 3 to 6 drops.—*Zeitschrift fur Analytische Chemie.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
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ANTIMONY.

After some earlier, unsatisfactory determinations, Berzellius,† in 1826, published his final estimation of the atomic weight of antimony. He oxidised the metal by means of nitric acid, and found that 100 parts of antimony gave 124·8 of Sb_2O_4. Hence, if O=16, Sb=129·03. The value 129 remained in general acceptance till 1855, when Kessler,‡ by special volumetric methods, showed that it was certainly much too high. Kessler's results will be considered more fully further along, in connection with a later paper; for present purposes a brief statement of his earlier conclusions will suffice. Antimony, and various compounds of antimony, were oxidised partly by potassium anhydrochromate and partly by potassium chlorate; and from the amounts of oxidising agent required, the atomic weight in question was deduced:—

By oxidation of Sb_2O_3 from 100 parts Sb ..	Sb=123·84
,, Sb with $K_2Cr_2O_7$..	,, 123·61
,, ,, $KClO_3+K_2Cr_2O_7$ ..	,, 123·72
,, Sb_2O_3 with ,, ,, ..	,, 123·80
,, Sb_2O_3 with $K_2Cr_2O_7$	,, 123·58
,, tartar emetic..	,, 119·80

The figures given are those calculated by Kessler himself. A recalculation with our newer atomic weights for O, K, Cl, Cr, S, and C, would yield slightly lower values. It will be seen that five of the estimates agree closely while one diverges widely from the others. It will be shown hereafter that the concordant values are all vitiated by constant errors, and that the exceptional figure is after all the best.

Shortly after the appearance of Kessler's first paper, Schneider‖ published some results obtained by the reduction of antimony sulphide in hydrogen. The material chosen was a very pure stibnite from Arnsberg, of which the gangue was only quartz. This was corrected for, and corrections were also applied for traces of undecomposed sulphide carried off mechanically by the gas stream, and for traces of sulphur retained by the reduced antimony. The latter sulphur was estimated as barium sulphate. From 3·2 to 10·6 grms. of material were taken in each experiment. The final corrected percentages of S in Sb_2S_3 were as follows:—

28·559
28·557
28·501
28·554
22·532
28·485
28·492
28·481

Mean 28·520 ± 0·008

Hence, if S=32, Sb=120·3.

Immediately after the appearance of Schneider's memoir, Rose§ published the result of a single analysis of antimony trichloride, previously made under his supervision by Weber. This analysis, if Cl=35·5, makes Sb=120·7, a value of no great weight, but in a measure confirmatory of that obtained by Schneider.

The next research upon the atomic weight of antimony was that of Dexter,¶ published in 1857. This chemist, having tried to determine the amount of gold precipitable by a known weight of antimony, and having obtained discordant results, finally resorted to the original method of Berzelius. Antimony, purified with extreme care, was oxidised by nitric acid, and the gain in weight was determined. From 1·5 to 3·3 grms. of metal were used in each experiment. The reduction of the weights to a vacuum standard was neglected as being superfluous. From the data obtained we get the following percentages of Sb in Sb_2O_4:—

79·268
79·272
79·255
79·266
79·253
79·271
79·264
79·260
79·286
79·274
79·232
79·395
79·379

Mean 79·283 ± 0·009

Hence, if O=16, Sb=122·46.

The determinations of Dumas* were published in 1859. This chemist sought to fix the ratio between silver and antimonious chloride, and obtained results for the atomic weight of antimony quite near to those of Dexter. The $SbCl_3$ was prepared by the action of dry chlorine upon pure antimony; it was distilled several times over antimony powder, and it seemed to be perfectly pure. Known weights of this preparation were added to solutions of tartaric acid in water, and the silver chloride was precipitated without previous removal of the antimony. Here, as Cooke has since shown, is a possible source of error, for under such circumstances the crystalline argento-antimonious tartrate may also be thrown down and contaminate the chloride of silver. But be that as it may; Dumas's weighings, reduced to a common standard, give as proportional to 100 parts of silver, the quantities of $SbCl_3$ which are stated in the third of the subjoined columns:—

1·876 grms. $SbCl_3$	= 2·660 grms. Ag.	70·526
4·336 ,,	6·148 ,,	70·527
5·065 ,,	7·175 ,,	70·592
3·475 ,,	4·930 ,,	70·487
3·767 ,,	5·350 ,,	70·411
5·910 ,,	8·393 ,,	70·416
4·828 ,,	6·836 ,,	70·626

Mean 70·512 ± 0·021

Hence, if Ag=108, and Cl=35·5, Sb=122.

In 1861 Kessler's second paper† relative to the atomic weight of antimony appeared. Kessler's methods were somewhat complicated, and for full details the original memoirs must be consulted. A standard solution of potassium anhydrochromate was prepared, containing 6·1466 grms. to the litre. With this, solutions containing known quantities of antimony or of antimony compounds were titrated, the end reaction being adjusted with a standard solution of ferrous chloride. In some cases the titration was preceded by the addition of a definite weight of potassium chlorate, insufficient for complete oxidation; the anhydrochromate then served to finish the reaction. The object in view was to determine the amount of oxidising agent, and therefore of oxygen, necessary for the conversion of known quantities of antimonious into antimonic compounds.

In the later paper Kessler refers to his earlier work, and shows that the values then found for antimony were all too

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1.
‡ *Ibid.*, 95, 215.
‖ *Ibid.*, 98, 293. 1856. Preliminary note in Bd. 97.
§ *Ibid.*, 98, 455. 1856.
¶ *Ibid.*, 100, 563.

* *Ann. Chim. Phys.*, (3), 55, 175.
† *Poggend. Annal.*, 113, 145.

high, except in the case of the series made with tartar emetic. That series he merely states, and subsequently ignores, evidently believing it to be unworthy of further consideration. For the remaining series he points out the sources of error. These need not be re-discussed here, as the discussion would have no value for present purposes; suffice it to say that in the series representing the oxidation of Sb_2O_3 with anhydrochromate and chlorate, the material used was found to be impure. Upon estimating the impurity and correcting for it, the earlier value for Sb=123·80 becomes Sb=122·36, according to Kessler's calculations.

In the paper now under consideration four series of results are given. The first represents experiments made upon a pure antimony trioxide which had been sublimed, and which consisted of shining colourless needles. This was dissolved, together with some potassium chlorate, in hydrochloric acid, and titrated with anhydrochromate solution. Six experiments were made, but Kessler rejects the first and second as untrustworthy. The data for the others are as follows:—

Sb_2O_3.	$KClO_3$.	$K_2Cr_2O_7$ sol. in c.c.
1·7888 grms.	0·4527 grm.	19·2 c.c.
1·6523 ,,	0·4506 ,,	3·9 ,,
3·2998 ,,	0·8806 ,,	16·5 ,,
1·3438 ,,	0·3492 ,,	10·2 ,,

From these figures Kessler deduces Sb=122·16.

These data, reduced to a common standard, give the following quantities of oxygen needed to oxidise 100 parts of Sb_2O_3 to Sb_2O_5. Each cubic centimetre of the $K_2Cr_2O_7$ solution corresponds to one milligram. of O:—

10·985
10·939
10·951
10·936

Mean 10·953 ± 0·0075

In the second series of experiments pure antimony was dissolved in hydrochloric acid with the aid of an unweighed quantity of potassium chlorate. The solution, containing both antimonious and antimonic compounds, was then reduced entirely to the antimonious condition by means of stannous chloride. The excess of the latter was corrected with a strong hydrochloric acid solution of mercuric chloride, then, after diluting and filtering, a weighed quantity of potassium chlorate was added, and the titration with anhydrochromate was performed as usual. Calculated as above, the percentages of oxygen given in the last column correspond to 100 parts of antimony:—

Sb.	$KClO_3$.	$K_2Cr_2O_7$ sol. c.c.	Per cent O.
1·636 grms.	0·5000 grm.	18·3	13·088
3·0825 ,,	0·9500 ,,	30·2	13·050
4·5652 ,,	1·4106 ,,	45·5	13·098

Mean 13·979±0·0096

This series gave Kessler Sb=122·34.

The third and fourth series of experiments were made with pure antimony trichloride, $SbCl_3$, prepared by the action of mercuric chloride upon metallic antimony. This preparation, in the third series, was dissolved in hydrochloric acid, and titrated. In one experiment solid $K_2Cr_2O_7$ in weighed amount was added before titration: in the other two estimations $KClO_3$ was taken as usual. If, according to Siewert's work, we take Cr=52·009, the percentages of oxygen in the last column correspond to 100 parts of $SbCl_3$:—

Grm. $SbCl_3$					Per cent O.
1·8576	needed 0·5967	$K_2Br_2O_7$	and 33·4	c.c. sol.	7·0338
1·9118	,, 0·3019	$KClO_3$	,, 16·2	,,	7·0321
4·1235	,, 0·6801	,,	,, 23·2	,,	7·0222

Mean 7·0294 ± 0·0024

The fourth set of experiments was gravimetric. The solution of $SbCl_3$, mixed with tartaric acid, was first precipitated by hydrogen sulphide, in order to remove the antimony. The excess of H_2S was corrected by copper sulphate, and then the chlorine was estimated as silver chloride in the ordinary manner. 100 parts of AgCl correspond to the amounts of $SbCl_3$ given in the third column:—

1·8662 grm. $SbCl_3$	gave 3·483	grm. AgCl.	53·580
1·6832 ,,	3·141	,,	53·588
2·7437 ,,	5·1115	,,	53·677
2·6798 ,,	5·0025	,,	53·569
5·047 ,,	9·411	,,	53·629
3·8975 ,,	7·2585	,,	53·696

Mean 53·623 ± 0·015

The volumetric series with $SbCl_3$ gave Kessler values for Sb ranging from 121·16 to 121·47. The gravimetric series, on the other hand, yielded results from Sb=124·12 to 124·67. This discrepancy Kessler rightly attributes to the presence of oxygen in the chloride; and, ingeniously correcting for this error, he deduces from both sets combined the value of Sb=122·37.

The several mean results for antimony agree so fairly with each other, and with the estimates obtained by Dexter and Dumas, that we cannot wonder that Kessler felt satisfied of their general correctness, and of the inaccuracy of the figures published by Schneider. Still, the old series of data obtained by the titration of tartar emetic with anhydrochromate contained no evident errors, and was not accounted for. This series,* if we reduce all of Kessler's figures to a single common standard, give a ratio between $K_2Cr_2O_7$ and $C_4H_4KSBO_7.\frac{1}{2}H_2O$. 100 parts of the former will oxidise of the latter:—

336·64
338·01
336·83
337·93
338·59
335·79

Mean 337·30 ± 0·29

From this, if $K_2Cr_2O_7$=294·64, Sb=119·18.

(To be continued.)

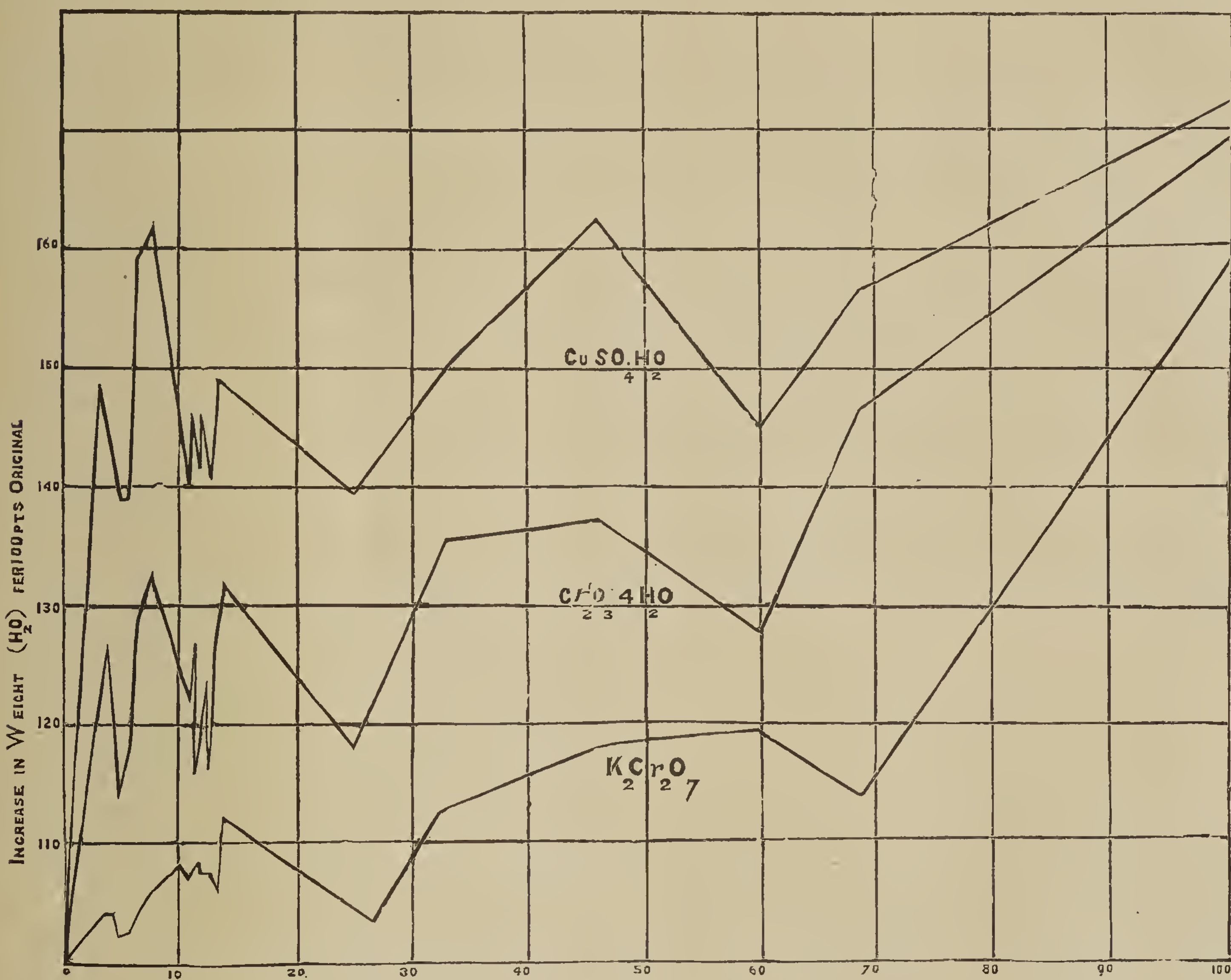
HYDRATION OF SALTS AND OXIDES.

By C. F. CROSS.

This subject may be approached from several points of view, each with its own experimental method. Thorpe and Watts† have studied the hydration of salts in the light of the volumes occupied by the successive molecules of water of hydration; Favre and Valson‡ have determined the heat constants for the solution of salts of varying degrees of hydration, and thus endeavoured to throw light upon the mode of union of water of crystallisation; Hannay and Ramsay|| have taken up the subject from the dynamic side, applying the time method to the observation of the dehydration of salts and oxides. Lastly, I have endeavoured§ to follow the phenomena of rehydration, by means of a special method and apparatus. I have shown that when a salt is deprived of its water of crystallisation and exposed to an atmosphere saturated with aqueous vapour, it quickly combines with water up to the original limit; that here a break occurs of greater or less duration,

* *Poggend. Annal*, 95, 217.
† *Journ. Chem. Soc.*, 37, 102.
‡ *Compt. Rendus.*, vols. 73, 74, 75.
|| *Journ. Chem. Soc.*, 1877, 381.
§ *Ibid.*, 35, 796. Chemical News, vol. 44, pp. 101, 209; vol. 47, 239.

followed by that further combination of water which is known as deliquescence. An anhydrous salt, or a salt containing its limiting quantity of water of crystallisation, passes immediately into this phase of deliquescence, or incipient solution, and these several phenomena are continuous manifestations of the same attractive energy. The hydration of oxides, although so dissimilar in its visible results, follows a similar course: and to demonstrate more clearly these common features of resemblance I have undertaken and completed a series of parallel observations upon three substances selected as types of these various modes of rehydration, viz., $CuSO_4.H_2O$, $K_2Cr_2O_7$, and $Cr_2O_3.4H_2O$.



1 – 100 Days

The results are graphically represented by the accompanying curves, each of which originates at the same 0 point, corresponding to 100 pts. of substance; the ordinates therefore represent the percentage increase due to combination with water. The period over which the observations extended was from May to August, 1883; the limits of temperature observed were 16—21°.

The similarity of these curves to one another in their main features is unmistakeable.

The course of hydration in the case of the copper sulphate was marked by the gradual contraction of the area of the deliquescing solid: from covering a circular area of 70 m.m. diameter at the beginning of the experiment, it occupied at the close an area equally regular and concentric with the former, but of not more than half that diameter.

The potassium dichromate presented throughout a very different appearance; the course of hydration was from the beginning rather one of liquefaction than deliquescence, the yellow solution of the salt very early making its appearance upon the scale pan.

The chromic hydrate remained throughout to all appearances a dry solid, notwithstanding that at the close of the experiment it contained 60 per cent water and had taken up nearly as much water as the copper sulphate.

In a future communication it is my intention to discuss these and previous results, together with the collateral researches of other observers, mentioned at the beginning of this paper, in their bearings on the subject of hydration.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, May 1st, 1884.

The DUKE OF NORTHUMBERLAND, D.C.L., LL.D., President, in the Chair.

THE Annual Report of the Committee of Visitors for the year 1883, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The Real and Funded Property now amounts to above £85,400, entirely derived from the Contributions and Donations of the Members.

Thirty-seven new Members paid their admission fees in 1883.

Sixty-three lectures and nineteen evening discourses were delivered in 1883.

The books and pamphlets presented in 1883 amounted

to about 236 volumes, making, with 558 volumes (including periodicals bound) purchased by the managers, a total of 794 volumes added to the library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as officers for the ensuing year:—

President.—The Duke of Northumberland, D.C.L., LL.D.

Treasurer.—George Busk, Esq., F.R.S.

Secretary.—Sir William Bowman, Bart., LL.D., F.R.S.

Managers.—George Berkley, Esq., M.I.C.E.; Sir Frederick J. Bramwell, F.R.S.; Joseph Brown, Esq., Q.C.; Warren De La Rue, Esq., M.A., D.C.L., F.R.S.; Captain Douglas Galton, C.B., D.C.L., F.R.S.; Colonel James Augustus Grant, C.B., C.S.I., F.R.S.; The Hon. Sir Wm. Robt. Grove, M.A., D.C.L., LL.D., F.R.S.; Right Hon. The Lord Claud Hamilton, J.P.; Sir John Hawkshaw, F.R.S., F.G.S.; Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S.; Hugo W. Müller, Esq., Ph.D., F.R.S.; Sir Frederick Pollock, Bart., M.A.; John Rae, M.D., LL.D., F.R.S.; The Earl of Rosse, D.C.L., LLD., F.R.S.; The Hon. Rollo Russell, F.M.S.

Visitors.—John Birkett, Esq., F.L.S., F.R.C.S.; Charles James Busk, Esq.; Stephen Busk, Esq.; George Frederick Chambers, Esq., F.R.A.S.; William Crookes, Esq., F.R.S.; Rear-Admiral Herbert P. De Kantzow, R.N.; William Henry Domville, Esq.; Alexander John Ellis, Esq., B.A., F.S.A., F.R.S.; Rev. John Macnaught, M.A.; Robert James Mann, M.D., F.R.C.S.; Sir Thomas Pycroft, M.A., K.C.S.I.; Lachlan Mackintosh Rate, Esq., M.A.; John Bell Sedgwick, Esq., F.R.G.S.; Basil Woodd, Smith, Esq., F.R.A.S.; Charles Meymott Tidy, Esq., M.B., F.C.S.

OBITUARY.

DR. ROBERT ANGUS SMITH, F.R.S., F.C.S., &c.

The announcement of the death of one of the oldest, most conscientious, and zealous workers in the field of Chemistry will be received by our readers and by a wide scientific circle with much sorrow. After an illness extending over several months, and indeed having been in a poor state of health for the last few years, Dr. Smith expired on the 11th inst., at Colwyn Bay, near Llandudno.

Dr. Smith was born near Glasgow in 1817, and educated first at the Grammar School, and afterwards at the University of that city. His aptitude, which early showed itself, for classical studies induced his parents to regard the Scotch Kirk as a suitable profession for their son, but his early experiences of the arbitrary dogmatism of this religious sect proved such a profession to be incompatible with his opinions, and he, like many others for the same reason, sought other more consistent channels into which to direct his energy. After spending several years as private tutor in Scotland, and ultimately in London, Dr. Smith went, in 1839, to the University of Giessen, to study Science: here he had as companions and fellow-workers men many of whom have become well known by their scientific investigations. Returning to England in 1841, he became assistant to Dr. Lyon Playfair, who was at that time engaged on a sanitary commission, and it was the investigations connected with this occupation that formed the starting-point of Dr. Smith's subsequent work on sanitary matters which are especially linked with his name.

His first paper appeared in 1846, in the *Journal of the Chemical Society*. Two years later he read a highly important paper at the Meeting of the British Association at Swansea, "On the Air and Water of Towns," several of the conclusions which he arrived at being remarkably interesting with regard to the presence of putrescible organic matter in the air of crowded rooms, and the existence of nitrates in well-waters in the vicinity of houses and towns, indicating previous pollution of the water by sewage or other animal matter. These papers were followed by two others,—"On the Air of Towns," and "On the Air and Rain of Manchester,"—both of much sanitary value.

As a tribute to the memory of Dalton Dr. Smith compiled, in 1854, a valuable History of the Atomic Theory and Memoir of Dalton, a work which, although now out of print for many years, was of considerable importance, due to the author's analyses of Richter's and Wenzel's claims to the discovery of the law of reciprocal decomposition.

Between the years 1855 and 1863 Dr. Smith contributed several papers to the Chemical Society, the Society of Arts, and the Philosophical Society of Manchester, "On Sewage and Sewage Rivers," "Disinfectants," "On the Composition of Rosolic Acid," and "On Putrefaction in Blood," some of his conclusions and experimental results being of much value from a sanitary point of view. In 1863 he was appointed Inspector-General of Alkali Works, and for this post probably a not more fit person could have been selected, as the work connected with it was essentially of that character to which he had devoted many years of experimental research. His "Report on the Air of Mines and Confined Places," which formed an Appendix to the "Report of the Royal Mines Commission, was published in 1864, and contained many valuable facts relating to ventilation, and such like; and his annual "Reports under the Alkali Act" form important contributions to sanitary science, as well as his papers "On some Physiological Effects of Carbonic Acid and Ventilation," and "On the Composition of the Atmosphere."

In 1869 Dr. Smith published his work on "Disinfectants and Disinfection," being for the most part a collection of his contributions to the various journals on this subject, and his "Report to the Cattle Plague Commission." Three years later his work on "Air and Rain" was published; and in 1876 Dr. Smith, in conjunction with the late Mr. J. Young, F.R.S., collected and printed in one large volume, for presentation only, the "Chemical and Physical Researches of Graham"; and in 1883, to commemorate the centenary of the Manchester Philosophical Society, he wrote a long and very interesting history of this Society, with biographical sketches of many of its most notable members. In addition to these more important contributions to Science, Dr. Smith has published many papers of minor interest, as "On the Absorption of Gases by Charcoal," "Some Invisible Agents of Health and Disease," "On the Measurement of the Actinism of the Sun's Rays and of Daylight," as well as several Essays and works of antiquarian interest; one of the last being a volume entitled "Loch Etive and the Sons of Uisnach," which was published anonymously. He was for many years a contributor to the Chemical News, most of his Reviews and Essays in these pages being, however, unsigned.

Dr. Smith was elected a Fellow of the Royal Society in 1857; he was a Corresponding Member of the Royal Bavarian Academy, Vice-President of the Chemical Society, of the Literary and Philosophical Society of Manchester, and of the Institute of Chemistry. He assisted in the Jury of the Exhibition of 1862 and of the French Exposition in 1878. In 1882 the degree of LL.D. was conferred upon him by the University of Edinburgh.

PROFESSOR WURTZ.

Little did we think when reading the eloquent *eloge* pronounced by Professor Wurtz at the tomb of J. B. Dumas how soon the speaker was to follow his illustrious colleague to the silent land.

C. A. Wurtz was born at Strassburg on November 16,

1817, being thus of the same age as Dr. R. Angus Smith, whose death coincides so closely with his own.

We first hear of Wurtz as assistant in the laboratory of Dumas, who became his firm friend. His first official appointment was the Professorship of Chemistry at the Agricultural Institute of Versailles. Since 1858 he has filled the Chair of Chemistry at the Faculty of Medicine, at Paris, and has latterly been, in addition, Professor of Chemistry at the Sorbonne.

The life of the late distinguished *savant* presents little of outward interest, but it is singularly rich in important and successful research. He may justly rank as one of the founders of modern organic chemistry. For many years he has been one of the most active members of the Academy of Sciences, where his death, following so closely upon that of Dumas, will leave a painful void, and must, if we may use the expression, derange the balance of power in that learned body as far as chemistry is concerned. According to the Royal Society Catalogue he had produced seventy-three memoirs up to the year 1864, and during the subsequent twenty years he has shown no disposition to rest upon his laurels. Readers of the *Comptes Rendus* will have remarked his occasional controversies with Prof. Berthelot on points of chemical theory, and especially with reference to the question between atoms or equivalents. In these discussions Wurtz generally appears to have had the advantage.

His earliest published investigation, which dates back as far as 1842, was on the constitution of the hypophosphites. He next studied phosphorus and sulphophosphoric acid, and threw a new light on the compounds of phosphorus. One of his earlier discoveries was that of copper hydride, a remarkable, and it may be said in many respects exceptional, compound. Wurtz noted in particular that this hydride is quickly dissolved by strong hydrochloric acid, which is without action upon free metallic copper.

He next turned his attention to the cyanic and cyanuric ethers, and in 1849 he discovered the compound ammonias formed when an atom of hydrogen in ammonia is replaced by an organic radicle, such as ethyl or methyl.

His next research bore upon the discussion between Frankland and Kolbe on the one hand, and Laurent, Gerhardt, and Hofmann on the other, as to whether the radicles isolated from alcohols remained free (as maintained by the former two chemists) or combined with themselves (as shown by the latter.) Wurtz succeeded in producing decisive evidence of the correctness of the latter view. He found, on treating a mixture of the iodides of two different radicles with sodium, that a hydrocarbon was obtained, formed by the union of the two different radicles.

His subsequent researches have been too numerous to mention, and, indeed, any recapitulation of their subjects and their results is the less necessary as they have been duly noticed in the Chemical News at the time of their appearance.

Professor Wurtz was a Fellow of the Royal Society, and on November 12th, 1878, the Fellows of the Chemical Society had the pleasure of hearing him deliver the Faraday Lecture for that year.

NOTICES OF BOOKS.

Gas Works Statistics, 1884: compiled from Special Returns received from Engineers and Secretaries throughout the United Kingdom. Edited by Charles W. Hastings. London: Scientific Publishing Company, Limited.

We have here, arranged in parallel columns, the tons of coal carbonised, the annual make and sale of gas in thousands, the price per thousand, the number of consumers, the price paid for public lamps, their number, the average price received for coke, the tons of ammonium sulphate made, and—most important feature of all in the eyes of shareholders—the dividend.

It will be noted that between the volume of gas made and the volume sold there is often a wide difference, amounting, in one case, to one-fourth of the entire production! The question at once arises, what becomes of the remainder? Does it escape, tainting the air and the soil? We should recommend those concerned to look closely to the condition of their mains. There is, on the other hand, one case at least where the quantity sold *exceeds* the quantity made. Whether we have here proof of the introduction of air or of defective bookkeeping we cannot presume to say.

There is no mention of the quality of coal consumed in each case, nor of the quantity of coal-tar produced and its especial properties. Information of this kind would be very useful, as the tars made from different classes of coal vary widely in the proportions of their constituents, and consequently in the purposes for which they are best adapted.

In quality and price gas varies greatly. Leeds supplies a 20-candle gas at 1s. 10d. per thousand, subject to 2½ per cent discount. On the other hand, some dozen towns charge 7s., 7s. 6d., or upwards, and, as a rule, modestly omit to give any return of its illuminating power. Two only of this class confess that their gas is of the exceedingly low power of 12-candles. These are the only two instances of such a poor quality recorded. The richest gas mentioned is that of Berwick-upon-Tweed, which is of 30-candle power.

Water-Works Statistics, 1884: compiled from Special Returns received from Engineers and Secretaries throughout the United Kingdom. Edited by Charles W. Hastings. London: Scientific Publishing Company, Limited.

In this useful compilation we find an alphabetical list of the towns in the United Kingdom, with the sources of their water supply, the yearly quantity of water furnished, the method of changing the nature of the service whether constant or intermittent, and the dividend paid in cases where the works are not the property of the municipality. These dividends fluctuate greatly, but are, as a whole, very high for undertakings where the demand is constant. Ten per cent is a very frequent figure; the London New River Company rejoices in 12½, and the Basingstoke Company in 20! We notice only three cases of an intermittent supply where the water-works belong to the municipality—Shrewsbury, Swindon, and Tunbridge Wells. The evils of the intermittent system are glaring. It necessitates the cistern, which serves as a gathering-ground for pollution of varied kinds, and which, in most houses, is the point open to the attacks of frost. That the Companies, in the long run, gain anything by the intermittent system is at least questionable, if we consider the pay of the turncocks and the waste of water when it remains turned on after the cistern is full—the ball-cock not unfrequently refusing to act.

No information is given as to the quality of the different water supplies. We should suggest that a classification of the waters into hard or soft would be more generally useful than the information given as to whether the supply is obtained by pumping or by gravitation. Such a tabular view would throw considerable light on the question whether hard or soft waters are dietetically preferable.

The supply of water by meter, instead of by a percentage on the rental or rateable value, seems extending,—a movement in the right direction.

The Gas and Water Companies' Directory, 1884. Edited by Charles W. Hastings. London: Scientific Publishing Company, Limited.

This Directory embodies some features different from those which we find in the "Gas Works Statistics" and "Water

Works Statistics" by the same author. It gives the date of formation; the special Act, if any; the total share capital paid up; the dividends; the total loan capital issued; name of chairman, engineer, or manager, lessee, owner, or corporation; the population of the town or village, its distance from London, and the railway by which it is accessible. As far as we are able to judge, the information given is accurate, and the work will be useful to shareholders and to persons doing business with the various companies. Technological and sanitary features are, of course, wanting.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 13, March 31, 1884.

The Specific Heat of the Gaseous Elements at very High Temperatures.—MM. Berthelot and Vielle. At about 4500° the elementary specific heat of the following simple gases is increased threefold: hydrogen, nitrogen, oxygen. Chlorine, bromine, and iodine have molecular specific weights decidedly higher than those of the other elements, and not differing greatly from the specific heats of the compound gases formed with the contraction of one-third, such as watery vapour, nitrogen protoxide, and carbonic anhydride. At 1800° the mean specific heat of chlorine is about three times that of hydrogen.

Origin of Lactose.—Paul Bert.—This compound is produced by the excretion of the excess of sugar formed by the organism after parturition. It is probably produced in the liver.

Separation of Gallium from Organic Matter.—Lecoq de Boisbaudran,—The author gives two processes for the simultaneous determination of gallium and tartaric acid, which he considers available in presence of most other organic matters. (1) The gallium is precipitated with a slight excess of potassium ferrocyanide in a very acid hydrochloric solution. To the filtrate is added copper chloride, which throws down copper ferrocyanide. This is filtered off, and the filtrate is treated with a current of sulphuretted hydrogen, which removes the copper as a sulphide. The filtrate placed in a vacuum over caustic potassa is reduced to a small volume, and contains merely tartaric acid, potassium chloride, a little hydrochloric acid, and traces of iron, which are removed by well-known methods.—(2) The solution, slightly acid, is mixed with an excess of acid ammonium acetate and a certain quantity of arsenious acid, and is then treated with sulphuretted hydrogen. The arsenic sulphide carries down the gallium, whilst the tartaric acid remains in the liquid, and is separated from the ammonia and acetic acid by the usual methods. If it is merely intended to determine the gallium the substance may be ignited, and the ash melted with acid potassium sulphate. Chlorides must not be present, as they would cause the volatilisation of a part of the gallium.

Modification in the Earth Conductors of Lightning-Rods.—A. Callaud.—The author coats every wire of the cable with hemp saturated with ceruse or with red lead.

Transportation of the Ions, and its Relation to the Conductivity of Saline Solutions.—E. Bouty.—The electrolyses become more and more normal as the solutions employed are more dilute.

Measure of the Dissociation-Tension of Mercury Iodide.—L. Troost.—At a pressure of 750 m.m. the dissociation-tension of the vapour of mercury iodide is about 150 m.m. This tension corresponds to the fraction of mercury iodide which has been decomposed, and which is about one-fifth.

Resistance of the Carbons employed in Electric Lighthouses.—F. Lucas.—This paper is not adapted for useful abstraction.

General Theory of Dissociation.—M. Isambert.—A mathematical paper which cannot be usefully abridged.

Phenomenon of the Crystalline Superheating of Sulphur.—D. Gernez.—Not suitable for abridgment.

Non-Existence of Ammonium Hydrate.—D. Tommasi.—The combination-heat of ammonium hydrate, so-called, as calculated and as found experimentally, are respectively 54·2 and 21. Hence the author infers that the constitution of an ammoniacal solution is different from that of the alkaline hydrates.

Decomposition by Water of the Compounds of Cuprous Chloride with Potassium Chloride and Hydrochloric Acid.—H. Le Chatelier.—The author gives his results in the form of tables.

Composition of Pitch-blende.—M. Blomstrand.—Pitch-blende is a mixture of uranine, silicates, calcium carbonate, and iron sulphide. Uranine itself contains $U_7Pb(O_6U)_5$.

Determination of Phosphoric Acid in Arable Soils.—G. Lechartier.—The author criticises the process of M. Gasparin. He finds that if the sample is treated, as the latter chemist proposes, with aqua-regia, the solution precipitated with ammonia, the precipitate dried, and strongly ignited, nitric acid at one-fiftieth in the cold does not dissolve out the whole of the phosphoric acid. M. Lechartier modifies the process by precipitating with pure milk of lime in place of ammonia. The precipitate, after drying and ignition, is finely powdered, and digested at 50° to 60° with nitric acid at one-tenth. In this manner the whole of the phosphoric acid is dissolved out along with a little ferric oxide, and is then determined by the molybdic method. The solution must be suitably diluted, and must contain an excess of nitric acid. After an excess of the molybdenum mixture has been added, the liquid is quickly heated to near 100°. Until it is quite clear it is kept at a gentle heat for two or three hours, preventing loss by evaporation. If, in spite of these precautions, a yellowish residue appears after dissolving the precipitate in ammonia, it must be re-dissolved in a little nitric acid and re-precipitated with molybdenum mixture.

Formation-Heat of Silver, Magnesium, and Lead Fluorides.—M. Guntz.

Thermo-Chemical Study of Hydro-fluosilicic Acid.—Ch. Truchot.

On Sodium Glyoxal-bisulphite.—M. de Forcrand.—These three thermo-chemical papers do not admit of useful abstraction.

Zeitschrift für Analytische Chemie. Vol. xxii., Part 4, 1883.

Determination of Humus in Arable Soils.—G. Loges.—In moor soils and in mixtures of moor and sand the determination of humus as loss on ignition is trustworthy. The method is useless in case of heavy clays and marsh-soils.

Determination of Potassa in Manures.—E. Dreyfuss.—Noticed under *Bulletin Soc. Chimique.*

Analysis of Extract of Malt.—W. Klinkenberg.

Analysis of Liquorice Juice.—C. L. Diehl.—These papers do not admit of useful abridgment.

A New Xanthinoid Compound in Human Urine.—G. Salomon.—The new compound, paraxanthine, is distinguished from the other xanthine compounds by its crystalline character. It contains nitrogen, fuses at 270°, burns at higher temperatures without residue, dissolves readily in hot water, forming a neutral solution. It does

not, like guanine, xanthine, and hypoxanthine, dissolve in caustic soda, but is precipitated thereby from its concentrated aqueous solution in microscopic retangular tables.

A Sensitive Reaction for Kynuric Acid.—M. Jaffé.—If this acid is mixed in a porcelain capsule with hydrochloric acid and potassium chlorate and evaporated to dryness on the water-bath, there remains a reddish residue, which, if moistened with ammonia, becomes brownish-green, and in a short time emerald-green. On the application of heat the colour changes to a dirty violet. Other constituents of normal urine do not produce this reaction.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

The Degree of Ph.D.—(Reply to G. F. E.)—This degree of Doctor of Philosophy is obtainable at any German University after residence of about three years: a non-German may sometimes obtain it in two years. Candidates must pass in three subjects. The degree is about equivalent in Germany to B A. in England, but is not quite equal in England to B.A. or M.A. probably. I am not aware that French or American Universities grant this degree, but it is possible. The degree is a convenient one.—G. A. KEYWORTH.

MEETINGS FOR THE WEEK

MONDAY, 19th.—Society of Arts, 8. "Fermentation and Distillation," by Prof. W. Noel Hartley.

TUESDAY, 20th.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.

WEDNESDAY, 21st.—Society of Arts, 8. "Telegraph Tariffs," by Lieut.-Col. C. E. Webber, R.E., C.B.
— Meteorological, 7.
— Pharmaceutical, 11 a.m. (Anniversary).

THURSDAY, 22nd.—Philosophical Club, 6.30.
— Society of Arts, 8. "Economic Applications of Seaweed," by Edward C. Stanford.
— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.

FRIDAY, 23rd.—Royal Institution, 8. "Distances of Fixed Stars, &c." by Mr. D. Gill, at 9.
— Quekett Microscopical Club, 8.

SATURDAY, 24th.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.
— Physical, 3. "On an Immersion Galvanometer, and on Kohlrausch's Metre Bridges for Alternating Currents," by Dr. W. H. Stone. "On a Speed Indicator," by Mr. Walter Baily. "On Eutexia, or Lowest Temperatures of Fusion," by Dr. Guthrie.

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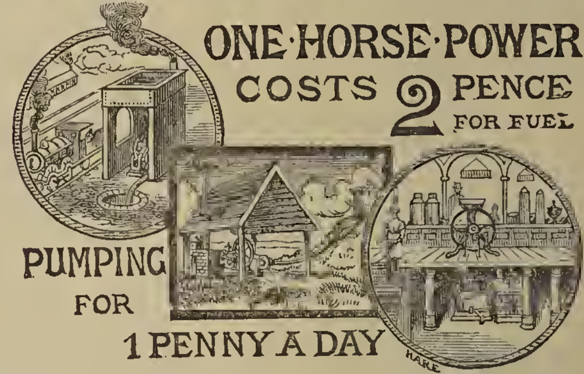

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1278.

SPECTROSCOPIC STUDIES ON GASEOUS EXPLOSIONS.*

By G. D. LIVEING, M.A., F.R.S., and JAMES DEWAR, M.A., F.R.S., Professors in the University ot Cambridge.

HAVING occasion to observe the spectrum of the flash of a mixture of hydrogen and oxygen fired in a Cavendish eudiometer, we were struck by the brightness, not only of the ubiquitous yellow sodium line, but of the blue calcium line and the orange and green bands of lime, as well as of other lines which were not identified. The eudiometer being at first clean and dry, the calcium must be derived either from the glass or from some spray of the water over which the gases with which the eudiometer was filled had been confined. It seemed incredible that the momentary flash should detach and light up lime from the glass, but subsequent observations have pointed to that conclusion. Our next experiments were made on the flash of the combining gases inclosed in an iron tube, half an inch in diameter and about 3 feet long, closed at one end with a plate of quartz, held in its place by a screw-cap, and made tight by leaden washers. Two narrow brass tubes were brazed into the iron tube at right angles to the axis, one near each end, and one of these was connected with an air-pump, the other with the reservoir of gas. Into one of these brass tubes was cemented a piece of glass tube with a platinum wire fused into it, whereby the electric spark was passed to fire the gas.

The tube was placed so that its axis might be in line with the axis of the collimator of a spectroscope, and the flash observed as it travelled along the tube.

It was seen at once that more lines made their appearance in the iron tube than in the glass vessel, and one conspicuous line in the green was identified in position with the E line of the solar spectrum. Several other lines were identified with lines of iron by comparison with an electric spark between iron electrodes. There could be no doubt that the flash in an iron tube gave several of the spectral lines of iron. We supposed that this must be due to particles of oxide shaken off the iron by the explosion, and proceeded to try the effect of introducing various substances in fine powder, and compounds, such as oxalates, which would give fine powders by their decomposition in the heat of the flame. Several interesting observations were made in this way. When some lithium carbonate was introduced, not only were the red, orange, and blue lines of lithium very brilliant, but the green line hardly less so. After the lithium had once been introduced into the tube, the lithium lines continued to make their appearance even after the tube had been repeatedly washed. When the lithium had been freshly put in, the red line was observed to be much expanded, very much broader than the line given by lithium in a Bunsen burner reflected into the slit for comparison. The light was dazzling unless the slit was very narrow; and it was noticed that if the spark by which the gas was fired was at the distant end of the tube, so that the flame travelled along the tube towards the slit, there was a reversal of the red line; a fine dark line was plainly visible in the middle of the band. When the spark was at the end of the tube next the slit, no reversal was, in general, seen. Later observations showed that some other metallic lines might be reversed in this way, and photographs taken of the reversals. These observations with the eye on the reversal of the red lithium line were made with a diffraction grating, and were repeated many times. They show that there are gradations of temperature in the flame, and that the front of the advancing wave of explosion is somewhat cooler than the following part. The combination of the gases is not so instantaneous that the maximum temperature is reached at once. When some magnesia was put into the tube the continuous spectrum was very bright, but the iron lines were still brighter. No lines which could be identified as due to magnesium was observed with certainty; there was only a doubtful appearance of *b*. With sodium, potassium, and barium carbonates, only the lines usually seen when salts of those metals are introduced into a flame were noticed; but eye observations of this kind are extremely trying, on account of the suddenness of the flash and the shortness of its duration. Thallium gave the usual green line.

Subsequently we had the interior of the tube bored out so as to present a smooth bright surface of iron, and noted the iron lines which were conspicuous in the flash.

For the purpose of identification the pointer in the eyepiece was first placed on one of the strong iron lines given by the electric discharge between iron electrodes, and then, the discharge being stopped but the field sufficiently illuminated, the eye was fixed steadily on the pointer while the gas in the tube was exploded. In this way it was not difficult to see whether any given line was very bright in the flash. The lines thus identified were those having the wave-lengths (about 5455, 5446, 5403, 5396, 5371, 5327, 5269 (E), 5167 (b_4). These lines were all many times observed in the way described, and as a rule were always present in the flash. Lines with wave-lengths about 5139 and 4352 were seen, and may possibly have been due to iron, and several more lines were seen occasionally, but were not so regularly seen that they could be well identified. The lines λ 4923 and λ 4919 were specially looked for, but neither of them could be seen. A group of blue lines were noticed, and were afterwards identified by photography, a method much less trying than observations by eye. To give intensity to the photographs ten or twelve flashes were usually taken in succession without any shift of the instrument, so as to accumulate their effects in one photograph. For identification the spark between iron electrodes was also photographed, but with a shutter over the lower part of the slit, so that the image of the spark should occupy only the upper part of the field.

The following is the list of wave-lengths of the iron lines thus photographed:—

4414·7	3885	3734·5
4404·2	3877·4	M 3727
4382·8	3859·2	3719·6
4325·2	3849·7	3709
4307·2	3840·3	3705·5
4271·3	3833·6	3647
4250·5	3827·6	3631
4201·5	3825·2	3618
4143·1	L 3819·3	3608·2
4131·5	3815·3	N 3580·5
4071	3799·3	3568·9
4062·9	3795	3564
4045	3787	3525·7
4004·7	3766·6	3496·8
3967	3763·4	3489·8
3929·7	3757·7	3476
3927·2	3749·5	3465·5
3922	3747·2	O 3440
3920	3745·3	
3902·5	3736·5	T 3019·8
3898·4		

As a rule no iron lines above O make their appearance; in a few plates T is visible, and it is possible that other lines may be obscured by the water spectrum, which always comes out and extends from near S to below R. Above T no line at all is visible in any of the photographs, though the spark lines come out strongly enough, and several of

* A Paper read before the Royal Society, April 3rd, 1884.

the strongest groups of iron lines, both of spark and arc lines, are in the region beyond T.

The spark by which the gas was fired passed in general between a platinum wire and the side of the small brass tube, and was out of view; but in order to make quite sure that the lines were not due at all to the spark, the brass tube was lined with a tube of platinum foil which projected beyond the brass tube a short distance into the larger tube, and the spark passed between the platinum wire and the platinum tube. It was found that the same iron lines made their appearance in the flash whichever way the spark was passed.

Other experiments were made with explosions of carbonic oxide and oxygen, and with coal-gas and oxygen. The explosions of these gases were attended with much more continuous spectrum, and the metallic lines were not always as well developed as they were with hydrogen and oxygen; but on the whole there were as many metallic lines photographed from the flashes of carbonic oxide as from those of hydrogen. There is an uncertainty about the explosion of the carbonic oxide mixture which we cannot account for, even when we take into account the remarkable effects of relative dryness of the gas on the explosions discovered by Mr. Dixon. Sometimes the explosions were so violent as to break the plate closing the end of the tube, though this had resisted the explosions of the hydrogen mixture, while at other times the wave of explosion passed slowly along the tube. The gas was in all cases confined over water, and passed directly from the gasholder into the tube.

When the iron tube was lined with copper-foil, only one copper line in the visible spectrum, $\lambda = 5104{\cdot}9$, was seen, and in the ultra-violet two lines, λ 3272 and λ 3245·5. All three lines were very strong, and the two ultra-violet lines were in some cases reversed. These lines were also frequently developed when no copper lining was in the tube, probably from the brass of the small side tubes.

Copper also gave a line in the indigo, λ 4281 about, decidedly less refrangible than the copper line, λ 4275, coincident apparently with the strong edge of one of the bands developed when a copper salt is held in a Bunsen burner.

A lining of copper which had been electroplated with nickel developed only one Ni line, λ 5476, in the visible part of the spectrum, but gave by photography the following lines in the ultra-violet:—

3807·5	3524	3445·5
? 3641	3514·7	3432
3618·3	3510	3422
3783	3492	3413·2
3775	3461·5	3391·5
3612·5	3457·7	3378·4
3597·3	3453	3369·6
3571·5	? 3451	3367·4
3565		

When nickel oxalate was put into the tube, lines with wave lengths 3670·5, 3470·3, and 3389·6 in addition to the preceding were developed. It is doubtful whether the line λ 3451 be a nickel line. That at $\lambda = 3453$ is ascribed to cobalt by Cornu, but it seems to be a nickel line as well.

When copper wire electro-plated with cobalt was put into the tube cobalt lines appeared with the approximate wave-lengths.

4119	3594	3492 ?
4089	3567	3474
3997	3528 }	3462
3911	3525 }	3453
3894	3522 }	3431
3871	3502	3411
3845	3495	3403
3601		

The lines λ 3528 to 3522 form a continuous band in the photograph, so that these three lines may not represent the whole group at that spot. It is doubtful whether λ 3492 be a cobalt line as well as a Ni line.

No other metal gave anything like the number of lines that were given by iron, nickel, and cobalt.

A lining of lead gave the lines λ 4057, 3683·3, and 3639·3 strongly, and these lines were frequently developed, though less strongly, when there was no lead lining; the metal being without doubt derived from the leaden washers used to make the ends of the tube air-tight.

A strip of silver gave the lines λ 3381·5 and 3278, and these lines were sometimes reversed. No trace of the channelled spectrum of silver was developed even when silver oxalate was put into the tube, and furnished plenty of silver dust after the first explosion.

A magnesium wire about 2 millims. thick and two-thirds the length of the tube gave the *b* lines very well; that is to say b_1 and b_2 were well developed, and b_4 was also seen, but as the iron and the magnesium components of b_4 are very close together, and the iron line had been observed before the introduction of the magnesium, it was not possible to say with certainty whether or not the magnesium line were present too. No other magnesium line could be detected. The blue flame line was carefully looked for, but could not be seen. The photographs showed none of the magnesium triplets in the ultra-violet, nor any trace of the strong line λ 2852, which appears in the flame of burning magnesium, and is yet more conspicuous in the arc when that metal is present.

Metallic manganese, introduced into the tube in coarse powder, gave the group at wave-length about 4029 with much intensity, but no other manganese line with certainty. In the visible part of the spectrum the channellings in the green due to the oxide were visible.

A lining of zinc produced no zinc line, and zinc-dust gave only a very doubtful photographic impression of the line λ 3342. A strip of cadmium gave no line of that metal either in the visible, or in the ultra-violet part of the spectrum.

Tin, aluminium, bismuth, and antimony, also failed to produce a line of any of those substances, and so did mercury which was spread over copper foil made to line the tube.

Thallium spread as amalgam over the copper lining gave the lines λ 3775·6, 3528·3 and 3517·8.

Chromium was introduced as ammonium bichromate, which of course left the oxide after the first explosion. This gave the chromium lines with wave-lengths about 5208, 5205, 5204, 4289, 4274·5, 4253·5, very well and persistently, also the lines with wave-lengths about 3605, 3592·5, 3578·5.

Sodium salts (carbonate, chloride) developed the ultra-violet line λ 3301; and potassium salts give the pair of lines about wave-length 3445; but no more refrangible line of either metal was depicted on the photographs. Lithium carbonate gave, besides the lines in the red, orange, green, and blue, the violet line, λ 4135·5; but no more refrangible line.

Photographs of a flame of mixed coal-gas and oxygen, in which an iron wire was burnt, show, as might be expected, the same iron lines as are developed in the flash of the detonating gases, and of the same relative intensities. These intensities are not quite the same relatively as they are in the arc spectrum. Thus the lines λ 3859, 3745, 3737, 3735, and 3719 come out in great strength, much stronger than the lines λ 3647, 3631, 3618, which are remarkably strong in the arc.

German-silver wire, burnt in the flame of coal-gas and oxygen, gave the same nickel lines as were given by nickel in the detonating gases, as well as those of copper and lead.

Copper wire gave, besides the lines λ 3274, 3245·5, a set of bands in the blue, which correspond with those given by copper salts in flames, and are probably due to the oxide.

The greater part of the lines which we have observed in the flames of the exploding gases have been observed by

us to be reversed when the several metals were introduced into the arc in a crucible of lime or magnesia; which is quite in accord with the supposition that the metals experimented on are volatile, and emit as well as absorb these particular rays at temperatures lower than that of the arc.

That iron is volatile at a temperature below the fusing point of platinum, which is about 1700° C., has been pointed out by Watts (*Phil. Mag.*, vol. xlv., p. 86), who observed in the flame of a Bessemer converter almost all the green and blue lines of iron which we have seen in the exploding gases, besides one or two lines which we have not observed or identified. Having regard to this volatility of iron, it does not seem so surprising that iron lines should be observed accompanying those of hydrogen to great heights in the sun's atmosphere as that they should not be always seen there.

It is remarkable that such volatile metals as mercury, zinc, and cadmium should give no lines in the flame of the exploding gases.

The gases exploded in the tube were generally mixed in nearly the proportions in which they combine chemically; but experiments were made with oxygen in excess and also with hydrogen and carbonic oxide in excess, a small excess of any one of the gases did not seem sensibly to affect the result, but on the whole the metallic lines were more certainly developed when there was not much excess of oxygen, and more constantly developed when hydrogen was used than when carbonic oxide was used.

The absence of any metallic lines in the flame of the exploding gases which are more refrangible than T may be in part due to a falling off in the sensibility of the photographic plates for light of shorter wave-length; but as the spark lines of iron seem to be quite as strongly depicted on the plates in regions of the spectrum far above T as they are in the regions below, we think that want of sensitiveness in the plates cannot be the only reason for the absence of higher lines, but that the emissive power of the metals for these lines is feeble at the comparatively low temperature of the flame.

Gony (*Comptes Rendus*, 1877, p. 232), using a modification of Bunsen's burner fed with gas mixed with spray of metallic salts, observed at the points of the inner green flame three or four iron lines which we have not observed in the flame of the detonating gas, the lines b_1 and b_2 of magnesium, two cobalt lines in the blue, which we have not seen, one line of zinc, and one of cadmium, and the two strong green rays of silver. Can the appearance of these rays under these circumstances imply that the temperature of the inner green cone of a Bunsen burner, when the proportion of air to coal-gas is near the exploding point, is higher than that of the explosion of hydrogen and oxygen?

The interesting theoretical questions which are suggested by the facts recorded in this paper we must leave for future discussion.

Cheap Engine for Raising Water.—An inquiry has just been held at Goole by Mr. J. T. Harrison, C.E., one of the Inspectors of the Local Government Board, with reference to the Local Board borrowing £6000 for works of sewage and street-making. The scheme was prepared by Mr. E. C. Buchanan Tudor, C.E., surveyor to the Board, who explained the plans in detail. There was no opposition, and the scheme was favourably considered. Mr. Tudor has also prepared and carried out a scheme for the south side of the town in Old Goole, which was visited by Mr. Harrison for the purpose of seeing the flushing arrangements, designed by Mr. Tudor, by pumping water from a deep bore hole with one of Bailey's hot-air engines, raising water 30 ft. high to a tank holding 21 tons. For 4d. per day for fuel, the whole contents of the tank are discharged down either line of 15-in. pipe in 120 secs. This is believed to be the cheapest method of raising water that has ever been discovered.—*Manchester City News.*

SUPERPHOSPHATE AND SUPERPHOSPHATE.

By FREDK. JAS. LLOYD, F.C.S.,
Lecturer on Agriculture, King's College.

MOST chemists, probably all agricultural chemists, are acquainted with the voluminous reports of Mr. T. Jamieson, in which, for some years past, he has recorded the results of his agricultural experiments, conducted formerly in Aberdeenshire, more recently in Sussex. They have led him to the conclusion that superphosphate is not merely an expensive and unnecessary manure, but an absolutely injurious one. Now the conclusion, if just, is of paramount importance to every agricultural chemist, to say nothing of the revolution which it would produce in the manufacturing world. It is, therefore, in my opinion, the duty of every agricultural chemist to sift the matter thoroughly, and without bias, and to determine for himself whether the results obtained justify the conclusion drawn. That Mr. Jamieson's experiments have been so conducted as to be open to severe criticism cannot be doubted, yet there is something in the results obtained which all the criticism the experiments have received fails to account for. This opinion is held by many, especially by agriculturists, who therefore believe that the experiments are of value in spite of the obloquy which has been thrown upon them.

What has struck me as most peculiar is the fact that no other experimenter, and there have been many, working at the same question, has confirmed Mr. Jamieson's results. This led me to ask the question, Does Mr. Jamieson use superphosphate similar to the superphosphate used by others in their experiments; in other words, has he used ordinary commercial superphosphate?

In Mr. Jamieson's reports the analyses of the manures he has used are given, though stated in a somewhat different style to that ordinarily employed by chemists.

The following is a copy of the analyses as given:—

Dissolved Coprolites.

	Aberdeenshire. 1876.	1878.	1880.	Sussex 1882.
Water	12·18	17·00	14·23	15·67
Organic matter, alkaline salts, &c.	0·98	3·80	5·20	7·56
Phosphoric anhydride	19·01	16·01	13·81	14·90
Sulphuric anhydride	25·22	31·81	37·51	33·06
Carbonic anhydride	1·65	—	—	—
Sand	7·23	3·68	3·92	4·25
Lime	29·08	25·31	22·53	23·25
Magnesia	0·41	—	—	—
Iron and alumina	4·24	2·39	2·80	1·31
	100·00	100·00	100·00	100·00
Phosphoric anhydride soluble in water	9·49	12·00	12·45	11·75

It is possible to calculate from these data what is the exact composition of the superphosphates. The soluble phosphoric anhydride will be present as monocalcic phosphate. The remainder of the phosphoric acid will presumably be present as tricalcic phosphate—there might perhaps be some phosphate of iron, but it will be preferable to calculate the iron as sulphate. The lime not combined with phosphoric acid will exist as calcium sulphate. These calculations enable us to determine how much of the sulphuric anhydride exists in the superphosphates as free sulphuric acid. Moreover, by combining the constituents in this manner only a minimum of free sulphuric acid is shown, but probably some of the iron would not be present as sulphate, so that the amount of free sulphuric acid would be rather more than that stated.

The following table gives the analyses as obtained by these calculations, and these analyses may be fairly assumed to represent the composition of the superphosphates employed by Mr. Jamieson. By the side of these manures I have placed an analysis of a superphosphate which re-

presents the ordinary commercial article as supplied to and used by farmers throughout the country.

Composition of Superphosphates.

	Aberdeenshire. 1876.	1878.	1880.	Sussex. 1882.	Ordinary article.
Moisture	12·18	17·00	14·23	15·67	17·05
Organic matter &c...	5·96	3·80	5·20	7·56	4·94
Monocalcic phosphate	13·23	16·73	17·36	16·38	16·63
Equal to tricalcic phosphate (rendered soluble) ..	(20·72)	(26·19)	(27·18)	(25·65)	(26·04)
Insoluble tricalcic phosphate	20·78	8·75	2·97	6·87	3·52
Sulphate of lime ..	29 09	38·47	38·87	36·18	39·37
Sulphate of iron ..	8·48	4·78	5·60	2·62	6·16
Sulphuric anhydride *present as free acid*	3·05	6·79	11·85	10·47	3·32
Silica	7·23	3·68	3·92	4·25	9·01
	100·00	100·00	100·00	100·00	100·00

There is, then, an exceptional amount of free sulphuric acid in the manures which have been employed by Mr. Jamieson of late years; indeed, they must have been saturated with sulphuric acid, and the conclusion to which I am driven is that the superphosphate used by Mr. Jamieson in his experiments does not represent the superphosphate of commerce, the manure used by farmers throughout the country.

Thus, the difference between Mr Jamieson's results and the results of other experimenters is accounted for, and here also, I think, is the true explanation of some of Mr. Jamieson's extraordinary conclusions, conclusions which may be true of these special superphosphates, but are certainly not applicable to the general farming of the country.

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LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING APRIL 30TH, 1884.

By WILLIAM CROOKES, F.R.S.
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, May 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 161 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily (excepting during the Easter holidays), from April 1st to April 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

The general excellence in character of the water supplied during the previous quarter has been more than maintained by the supply of the past month. Of the 161 samples of water examined, the whole were, without exception, well filtered, clear, and bright. Their aëration was abundant; and in respect to degree of freedom both from colour and organic matter, their condition was wholly satisfactory. In no one sample was there found an excessive proportion of organic carbon; while the mean proportion amounted to 0·126 part in 100,000 parts of water, corresponding to less than a quarter of a grain of organic matter per gallon.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ESTIMATION OF PHOSPHORIC ACID.

REPORT OF THE SUB-COMMITTEE OF THE CHEMICAL TRADES SECTION OF THE LONDON CHAMBER OF COMMERCE.*

AT a meeting of the representatives of the Chemical Trades, which included, by invitation, non-members as well as members of the Chemical Trades Committee, held on March 14, the following resolution was passed:—"That the professional chemists be invited to meet and consider what means, if any, they can suggest by which the most accurate mean result may be arrived at, by any two chemists who may be named, in any Phosphate or Superphosphate contract."

At the first meeting on April 2 Mr. Ogston was asked to take the chair, and after a full discussion of all the matters relating to analysis and phosphates that had been mentioned at the various meetings of the Section, and having particular regard to the statements made by many of the representatives of the chemical trades, at the meeting held on March 14, it was proposed and seconded and resolved that before discussing any differences of methods, employed by the several members of the sub-committee, it would be desirable to ascertain what variation would be found in the analysis of a properly-prepared sample when made by the several analysts. Such a sample of Charleston Phosphate was prepared by two members of the committee, and a portion sent to each one for analysis by their ordinary methods. The results were compared at their next meeting, and the following figures represent the five determinations of Phosphoric Acid:—

Nos.	1.	2.	3.	4.	5.
Phosphoric acid ..	26·55	26·20	26·48	26·60	26·00
Equal to phosphate of lime	57 96	57·19	57·82	58·06	56·75

It will be seen here that the differences are not large, and probably do not vary to a greater extent than may be expected in substances of this character, and considering that in all cases the mean of two analyses are taken, the variation cannot be said to be of any serious importance. Upon discussion it was found that in four cases out of the five the "Magnesian" method alone had been employed in the analyses, and that in the fifth the mean of one test by that method and another by the Molybdenum process had been taken, the difference between the two being one-half per cent in the phosphoric acid.

It would appear from these results of the analysis of a phosphate,—by no means of the simplest composition—that fairly uniform percentages of phosphoric acid are indicated, and that there is uniformity of method in the practice adopted by the reporters, and as they believe by all the principal analysts engaged in the examination of phosphates in this country. The sample that was reported upon was, of course, prepared very carefully, but not more carefully than samples should always be dealt

* As confirmed by the Chemical Trades Section on April 30, 1884, and ordered to be printed and circulated.

with before being forwarded for analysis, and in reference to this part of the question it was agreed—

1st. That the manufacturers should be asked to send the ground samples in a very finely divided state, with a separate sample coarsely crushed, in which the determination of the water shall be made.

2nd. That the phosphoric acid shall be determined in the ground sample dried at 212° F. The moisture to be separately estimated in this, if it be desired, as well as in the rough sample.

3rd. That in the event of there being a difference of more than 1½ in the results of the two chemists in the phosphate of lime, these results shall be communicated to both of them, and their opinion requested as to the cause of difference.

It will be seen that the extreme difference in the five analyses above referred to is 1½ per cent in the phosphate of lime, and it is thought that it should not exceed 1½ per cent, in samples finely ground and prepared as we recommend.

(Signed) G. H. OGSTON,
JOHN HUGHES,
H. R. SMITH,
BERNARD DYER,
F. E. J. CRIDLAND,

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ANTIMONY.

(Concluded from p. 220).

THE newer atomic weights found in the previous chapters of this work will be applied to the discussion of all these series further along. It may, however, be properly noted at this point, that the probable errors assigned to the percentages of oxygen in three of Kessler's series are too low. These percentages are calculated from the quantities of $KClO_3$ involved in the several reactions, and their probable errors should be increased with reference to the probable error of the molecular weight of that salt. The necessary calculations would be more laborious than the importance of the figures would warrant, and, accordingly, in computing the final general mean for antimony, Kessler's figures will receive somewhat higher weight than they are legitimately entitled to.

Naturally, the concordant results of Dexter, Kessler, and Dumas led to the general acceptance of the value of 122 for antimony as against the lower figure of 120 of Schneider. Still, in 1871, Unger† published the results of a single analysis of Schlippe's salt, $Na_3SbS_4.9H_2O$. This analysis gave Sb=119·76, if S=32 and Na=23, but no great weight could be attached to the determination. It served, nevertheless, to show that the controversy over the atomic weight of antimony was not finally settled.

More than ten years after the appearance of Kessler's second paper the subject of the atomic weight of antimony was again taken up, this time by Professor Cooke. His results appeared in the autumn of 1877,‡ and were conclusive in favour of the lower value, approximately 120. For full details the original memoir must be consulted; only a few of the leading points can be cited here.

Schneider analysed a sulphide of antimony which was already formed. Cooke, reversing the method, effected the synthesis of this compound. Known weights of pure antimony were dissolved in hydrochloric acid containing a little nitric acid. In this solution weighed balls of antimony were boiled until the liquid became colourless; subsequently the weight of metal lost by the balls was ascertained. To the solution, which now contained only antimonious compounds, tartaric acid was added, and then with a supersaturated aqueous sulphhydric acid, antimony trisulphide was precipitated. The precipitate was collected by an ingenious process of reverse filtration, converted into the black modification by drying at 210°, and weighed. After weighing, the Sb_2S_3 was dissolved in hydrochloric acid, leaving a carbonaceous residue unacted upon. This was carefully estimated and corrected for. About two grms. of antimony were taken in each experiment and thirteen syntheses were performed. In two of these, however, the antimony trisulphide was weighed only in the red modification, and the results were uncorrected by conversion into the black variety and estimation of the carbonaceous residue. In fact, every such conversion and correction was preceded by a weighing of the red modification of the Sb_2S_3. The mean result of these weighings, if S=32, gave Sb=119·994. The mean result of the corrected syntheses gave Sb=120·295. In these eleven experiments the following percentages of S in Sb_2S_3 were established:—

28·57
28·60
28·57
28·43
28·42
28·53
28·50
28·49
28·58
28·50
28·51

Mean 28·5182 ± 0·0120

These results, confirmatory of the work of Schneider were presented to the American Academy in 1876. Still before publication, Cooke thought it best to repeat the work of Dumas, in order to detect the cause of the old discrepancy between the values Sb=120 and Sb=122. Accordingly, various samples of antimony trichloride were taken, and purified by repeated distillations. The final distillate was further subfected to several recrystallisations from the fused state; or, in one case, from a saturated solution in bisulphide of carbon. The portions analysed were dissolved in concentrated aqueous tartaric acid, and precipitated by silver nitrate, many precautions being observed. The silver chloride was collected by reverse filtration, and dried at temperatures from 110° to 120°. In one experiment the antimony was first removed by H_2S. Seventeen experiments were made, giving, if Ag=108 and Cl=35·5, a mean value of Sb=121·94. If we reduce to a common standard, Cooke's analyses give, as proportional to 100 parts of AgCl, the quantities of $SbCl_3$ stated in the third column:—

1·5974 grms.	$SbCl_3$ gave	3·0124	AgCl.	53·028
1·2533	,,	2·3620	,,	53·061
0·8876	,,	1·6754	,,	52·978
0·8336	,,	1·5674	,,	53·184
0·5326	,,	1·0021	,,	53·148
0·7270	,,	1·3691	,,	53·101
1·2679	,,	2·3883	,,	53·088
1·9422	,,	3·6646	,,	52·999
1·7702	,,	3·3384	,,	53·025
2·5030	,,	4·7184	,,	53·048
2·1450	,,	4·0410	,,	53·081
1·7697	,,	3·3281	,,	53·175
2·3435	,,	4·4157	,,	53·072
1·3686	,,	2·5813	,,	53·020
1·8638	,,	3·5146	,,	53·030
2·0300	,,	3·8282	,,	53·028
2·4450	,,	4·6086	,,	53·053

Mean 53·066±0·0096

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Archiv. der Pharmacie*, 197, 194. Quoted by Cooke.
‡ *Proceedings American Academy*, v. 13.

This mean may be combined with that of Kessler's series, as follows:—

Kessler	53·623 ±	0·015
Cooke	53·066	0·0096
General mean ..	53·2311	0·008

The results thus obtained with $SbCl_3$ confirmed Dumas's determination of the atomic weight of antimony as remarkably as the syntheses of Sb_2S_3 had sustained the work of Schneider. Evidently, in one or the other series a constant error must be hidden, and much time was spent by Cooke in searching for it. It was eventually found that the chloride of antimony invariably contained traces of oxychloride, an impurity which tended to increase the apparent atomic weight of the metal under consideration. It was also found, in the course of the investigation, that hydrochloric acid solutions of antimonious compounds oxidise in the air during boiling as rapidly as ferrous compounds; a fact which explains the high values for antimony found by Kessler

In order to render "assurance doubly sure," Professor Cooke also undertook the analysis of the bromide and the iodide of antimony. The bromide, $SbBr_3$, was prepared by adding the finely powdered metal to a solution of bromine in carbon disulphide. It was purified by repeated distillation over pulverised antimony, and by several recrystallisations from bisulphide of carbon. The bromine determinations resembled those of chlorine, and gave, if Ag=108 and Br=80, a mean value for antimony of Sb=120.

Reduced to a common standard, the fifteen analyses give the subjoined quantities of $SbBr_3$ proportional to 100 parts of silver bromide:—

1·8621 grms. $SbCr_3$ gave	2·9216 AgBr.		63·736
0·9856 ,,	1·5422	,,	63·909
1·8650 ,,	2·9268	,,	63·721
1·5330 ,,	2·4030	,,	63·795
1·3689 ,,	2·1445	,,	63·833
1·2124 ,,	1·8991	,,	63·841
0·9417 ,,	1·4749	,,	63·848
2·5404 ,,	3·9755	,,	63·901
1·5269 ,,	2·3905	,,	63·874
1·8604 ,,	2·9180	,,	63·756
1·7298 ,,	2·7083	,,	63·870
3·2838 ,,	5·1398	,,	63·890
2·3589 ,,	3·6959	,,	63·825
1·3323 ,,	2·0863	,,	63·859
2·6974 ,,	4·2285	,,	63·791
			Mean 63·830 ± 0·008

The iodide of antimony was prepared like the bromide, and analysed in the same way. At first, discordant results were obtained, due to the presence of oxyiodide in the iodide studied. The impurity, however, was removed by subliming the iodide in an atmosphere of dry carbon dioxide. With this purer material, seven estimations of iodine were made, giving, if Ag=108 and I=127, a value for antimony of Sb=120. Reduced to a uniform standard, Cooke's weighings give the following quantities of SbI_3 proportional to 100 parts of silver iodide:—

1·1877 grms. SbI_3 gave	1·6727 grms. AgI.		71·005
0·4610 ,,	0·6497	,,	70·956
3·2527 ,,	4·5716	,,	71·150
1·8068 ,,	2·5389	,,	71·165
1·5970 ,,	2·2456	,,	71·117
2·3201 ,,	3·2645	,,	71·071
0·3496 ,,	0·4927	,,	70·956
			Mean 71·060 ± 0·023

Although Cooke's work was practically conclusive, as between the rival values for antimony, his results were severely criticised by Kessler,* who, evidently, had read Cooke's paper in a very careless way. On the other hand, Schneider published in *Poggendorff's Annalen* a friendly review of the new determinations, which so splendidly vindicated his own accuracy. In reply to Kessler, Cooke undertook still another series of experiments with antimony bromide,* and obtained absolute confirmation of his previous results. To a solution of antimony bromide was added a solution containing a known weight of silver not quite sufficient to precipitate all the bromine. The excess of the latter was estimated by titration with a normal silver solution. Five analyses gave values for antimony ranging from 119·98 to 120·02, when Ag=108 and Br=80. Reduced to a common standard, the weights obtained gave the amounts of $SbBr_3$ stated in the third column as proportional to 100 parts of silver:—

2·5032 grms. $SbBr_3$ =	2·2528 grms. Ag.		111·115
2·0567 ,,	1·8509	,,	111·119
2·6512 ,,	2·3860	,,	111·115
3·3053 ,,	2·9749	,,	111·106
2·7495 ,,	2·4745	,,	111·113
			Mean 111·114 ± 0·0014

Schneider, also,† in order to more fully answer Kessler's objections, repeated his work upon the Arnsberg stibnite This he reduced in hydrogen as before, correcting scrupulously for impurities. The following percentages of sulphur were found:—

28·546
28·534
28·542

Mean 28·541 ± 0·0024

These figures confirm his old results, and may be fairly combined with them and with the percentages found by Cooke, as follows:—

Schneider, early series	28·520 ±	0·008
,, late ,, ...	28·541	0·0024
Cooke..	28·5182	0·0120
General mean	21·5385	0·0023

We have now before us the following ratios, good and bad, from which to calculate the atomic weight of antimony. The single results obtained by Weber and by Unger, being unimportant, are not included:—

(1). Percentage of S in Sb_2S_3, 28·5385 ± 0·0023
(2). ,, Sb in Sb_2O_4, 79·283 ± 0·009
(3). O needed to oxidise 100 parts $SbCl_3$, 7·0294 ± 0·0024
(4). O ,, ,, Sb_2O_3, 10·953 ± 0·0075
(5). O ,, ,, Sb, 13·079 ± 0·0096
(6). $K_2Cr_2O_7$: tartar emetic : : 100 : 337·30 ± 0·29
(7). Ag : $SbCl_3$: : 100 : 70·512 ± 0·021
(8). AgCl : $SbCl_3$: : 100 : 53·2311 ± 0·008
(9). Ag : $SbBr_3$: : 100 : 111·114 ± 0·0014.
(10). AgBr : $SbBr_3$: : 100 : 63·830 ± 0·008
(11). AgI : SbI_3 : : 100 : 71·060 ± 0·023

Three of these ratios give estimates for the molecular weight of antimony trichloride, and two give corresponding values for the bromide. These values may be combined, as follows: first, for the chloride we have—

From (3)	$SbCl_3$ = 227·094 ±	0·115
,, (7) .. .. ,,	227·771	0·091
,, (8) .. .. ,,	228·433	0·039
General mean ,,	228·225	0·034

Hence Sb=122·115 ± 0·055.

For the bromide we get—

From (9)	$SbBr_2$ = 358·926 ±	0·032
,, (10) .. .. ,,	358·935	0·060
General mean ,,	358·929	0·029

Hence Sb=119·625 ± 0·063.

* *Ber. d. Deutsch. Chem. Gesell*, 12, 1044. 1879.

* *Amer. Journ. Sci. and Arts*, May, 1880. *Berichte*, 13, 951.
† *Journ. f. Prakt. Chem.*, (2), 22. 131.

From all the data eight values for Sb may be deduced. These fall into two groups; the one near the number 120, the other not far from 122. In making the calculation the atomic weights found in previous chapters are applied; the value selected for chromium being that deduced from Siewert's experiments:—

1.	From Sb_2S_3, ratio (1) ..	Sb =	120·145	± 0·045	Low
2.	,, $SbBr_3$	,,	119·625	0·063	Low
3.	,, SbI_3, ratio (11) ..	,,	119·665	0·179	Low
4.	,, tartar emetic, ratio (6)	,,	118·690	0·278	Low
5.	,, Sb_2O_4, ratio (2) ..	,,	122·181	0·061	High
6.	,, $SbCl_3$	,,	122·115	0·055	High
7.	,, ratio (4)	,,	121·798	0·105	High
8.	,, ,, (5)	,,	122·053	0·094	High
	General mean	,,	121·027	0·025	
	General mean of values 1 to 4 ..	,,	119·935	0·036	
	,, ,, 5 ,, 8 ..	,,	122·092	0·035	

Although the means of the four lower values and of the four higher values are thus shown to be approximately equal in weight, we know from Cooke's experiments that the larger mean is vitiated by serious constant errors. Only in value 5, the result calculated from Dexter's experiments, has the constant error not been pointed out. Cooke considers it probable, however, that the Sb_2O_4 involved in this work contained traces of some lower oxide, which, if present, would render the atomic weight of antimony apparently too high. Chemically considered, the preponderance of evidence is strongly in favour of values 1 to 3, deduced from the experiments of Schneider and of Cooke. These give a general mean of Sb = 119·955 ± 0·036; or, if O = 16, this becomes Sb = 120·231.

This we may accept as most nearly the true result, and reject the data of Dexter, Dumas, and Kessler altogether.

Since this chapter was written, Pfeifer has compared the amount of antimony thrown down electrolytically, with the quantity of silver deposited by the same current in the same time. From rather meagre data he concludes that the atomic weight of antimony, thus determined, may be 121. Additional investigation is promised. The figures thus far published would weigh little as against Cooke's experiments. (*Ann. Chem. Pharm.*, 209, 161. 1881).

The following additional note has been communicated by the author:—

Since the foregoing chapter was first published, the following results have been obtained by Bongartz*:—Pure antimony was converted into sulphide, by solution in warm K_2S and precipitation by H_2SO_4. The sulphide was then oxidised with H_2O_2, and the sulphur estimated as $BaSO_4$. In 12 experiments, 100 parts of Sb were found to yield of $BaSO_4$ 290·306 ± 0·0436. Hence Sb = 120·183 ± 0·023. The values given by Bongartz himself with O = 15·96, S = 31·98, and Ba = 136 8, range from 120·091 to 120·390; in mean, 120·193.

* *Ber. der Deutsch. Chem. Gesell.*, 16, 1942. 1883.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, May 15, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—W. T. Burgess, E. J. Caley, R. D. Courtney, M. H. Foye, W. F. Grace, Baron Ferdinand von Mueller, H. Rogers, A. J. Watts.

Dr. J. H. GLADSTONE then read a paper "*On Refraction Equivalents of Organic Compounds.*" In this paper the author gives the results of observations which have been made from time to time since 1870. These results are contained in three tables giving the refractive indices, &c., of over 140 substances. Table I. contains the refractive indices of the liquid bodies from observations of the lines A, D, and H. Table II. gives a list of the solvents employed, and the percentage amount of substance dissolved. Table III. gives the specific refraction, dispersion, and refraction equivalent of all the substances as deduced from observations, and the theoretical refraction equivalent calculated from the values of the respective elements given below. The specific refraction is the refractive index for A minus 1 divided by the specific gravity, or—

$$\frac{\mu A - 1}{d}.$$

The specific dispersion is—

$$\frac{\mu H - 1}{d} - \frac{\mu A - 1}{d},$$

or, which is the same thing,—

$$\frac{\mu H - \mu A}{d},$$

The refraction equivalent is—

$$\frac{\mu A - 1}{d} \times \text{ the atomic weight.}$$

The following are the values of the elements:—Carbon saturated, 5·0; carbon in C_nH_n, 5·95; carbon double linked, 6·1; hydrogen, 1·3; oxygen joined by single bonds, 2·8; oxygen joined by a double bond, 3·4; nitrogen, 4·1; nitrogen in bases, NO_2, &c., 5·1; chlorine, 9·9; bromine, 15·3; iodine, 24·5; sulphur joined by single bonds, 14·1; sulphur joined by a double bond, 16·0. The author has not included in the tables the refraction equivalent calculated for the theoretical limit of the spectrum, because of the increasing uncertainty as to the position of such a limit. The author then gives the data by which the refraction equivalents of the above elements are calculated, and in conclusion draws special attention to two points,—the phenomena of dispersion, and the bearing of these optical phenomena on our views as to the structure of organic compounds.

Dr. ARMSTRONG asked if Dr. Gladstone had used benzene prepared from benzoic acid, as Meyer had shown that all benzene prepared from coal-tar contained thiophene, and thus the refraction equivalent of carbon in benzene might be affected. He ventured to protest against the use of the terms double linked, double bonds, &c., which he trusted would soon become obsolete. It would be better to speak of carbon in the ethylenic condition, &c. He also thought it would be most important, if possible, to determine the specific dispersion as well as the specific refraction.

Prof. McLEOD suggested that some use might be made of Capt. Abney's photographic results, and that it would be better to determine the refraction of liquids at a fixed distance from their melting-point rather than from their boiling point.

Mr. TURNER then read a paper "*On the Estimation of Silicon in Iron and Steel.*" The author has estimated the silicon, in samples of iron and steel containing from 0·06 to 22 per cent of silica, by the various methods usually employed, and comes to the conclusion that the method suggested by Watts is most generally applicable, and gives, when slightly modified, accurate results. The method (*Journ. Chem. Soc. Abstracts*, xlii., 1134) consists in passing dry chlorine free from air over the iron borings at a low red-heat. The chloride of iron volatilises, and is condensed in the colder portion of the combustion-tube, whilst the silicon chloride passes on, and is decomposed by passing it through water, which on evaporation yields the silica. Any slag and the silicon contained in it remain behind in the porcelain boat unattacked. The improvement suggested by the author is the use of a Will and Varrentrapp's bulb, to contain the water by which

the silicon chloride is decomposed. The loss of the silica, which used to adhere to the delivery-tube and the beaker, is thus avoided, as the bulb can be dried and weighed after the experiment. A table accompanies the paper, giving the results obtained by six different methods and six samples of iron and steel.

Dr. TILDEN then read a "*Note on the Melting-points and their Relation to the Solubility of Hydrated Salts.*" In a paper read before the Royal Society, in June, the author, in conjunction with Mr. Shenstone, proved that a relation existed between the melting-points of anhydrous salts and their solubility in water above 100°. In the present paper the author shows that a similar relation holds between the points of fusion of hydrated salts and their solubility below these temperatures. He has determined the melting-points of many salts, and gives the method by which the determinations were made. The temperature at which incipient fusion occurs is in many cases that at which the graphic curve representing the solubility suddenly turns upwards. In isomorphous salts, containing the same amount of water of crystallisation, the solubility and the fusibility stand in the same order at all temperatures below the point of fusion, the most fusible being the most soluble. The author is greatly in want of experimental data as to solubilities and melting-points, in order to extend the subject further.

A memoir detailing some minor "*Researches on the Action of Ferrous Sulphate on Plant-life,*" by Dr. A. B. GRIFFITHS. The author finds that 0·15 per cent of ferrous sulphate added to a solution of various salts aids, whilst 0·2 per cent is fatal to, the development of mustard-seeds, cabbage-plants, and some microscopic water-plants.

"*Note on Ferric Sulphocyanate,*" by A. J. SHILTON. The author finds that if a drop of dilute ferric chloride be allowed to fall into a solution of potassium sulphocyanide, the red colour at first formed is completely discharged. Also that a liquid containing enough ferric sulphocyanate to render it almost opaque is completely decolourised if boiled with an excess of hydrochloric acid. These effects are readily explained by the fact that the sulphocyanide is a powerful reducing agent.

The Society then adjourned to June 5th.

PHYSICAL SOCIETY.

May 10th, 1884.

Prof. F. GUTHRIE, President, in the Chair.

THE meeting was held in the Chemical Theatre of the Mason College, Birmingham. Members had previously visited some of the factories in the town, including Gillott's Pen Works. Dr. GUTHRIE, President, took the chair at 3 p.m., when Prof. J. H. POYNTING made a communication on "*An Experiment illustrating the Refraction of Water-Waves.*" The experiment was designed to illustrate, by means of waves in water, the refraction of waves when they pass from one medium to another in which their velocity is different. The apparatus consisted of a tank, 2 feet 6 inches square, with a plate-glass bottom. Water is poured into the tank to a depth of (say) 5 to 6 m.m. The lid of the tank consists of a calico screen, and is slightly tilted up. A lime-light under the tank projects the wave on a screen. Plates of glass, 3 or 4 m.m. thick, are placed in the tank, thus reducing the depth of water. If waves are sent across the tank they travel more slowly through the shallow water, and are seen to be refracted. When circular or lenticular plates are used the refracted waves are seen to converge to a focus.

Mr. C. J. WOODWARD exhibited an oxy-hydrogen lantern suitable for lecture purposes.

Dr. J. H. GLADSTONE took the chair, and Prof. GUTHRIE, President, exhibited a sealed tube containing 46·6 of tri-ethylamine and 53·4 of water. At temperatures between 0° C. and 18·3° C. the liquid forms a clear mixture. At 18·3° it becomes turbid, and at 26° C. almost perfect separation is effected. It was stated that all proportions of the two liquids containing about 15 per cent and 50 per cent of tri-ethylamine become turbid at the same temperature. A mixture containing 4 per cent requires a temperature of 41° C. to produce turbidity, while one containing 90 per cent is turbid at 6° C. A series of sealed glass bulbs, containing the liquid in different proportions, can be employed to indicate the fever temperature of the body if placed under the tongue. The author also showed the connection between such separation by heat and the separation between the same two bodies by cold, whereby in the latter case, according to the strength of the solution, either ice or subcryohydrate is separated until the composition and temperature of the cryohydrate is reached (19·2 per cent; −3·8° C.). The peculiar white condensed vapour of the chloride of tri-ethylammonium was exhibited. The white fume of this body so quickly aggregates into masses that the shapes of the smoke lines and curls are preserved.

Dr. GLADSTONE agreed with the author in supposing that the separation of tri-ethylamine and water was continuous in nature with the separation of ammonia from water by heat.

Dr. TILDEN exhibited a tube containing a cold clear solution of amylic alcohol in water, which became turbid on gently warming and clear again on heating to about 60° C. He suggested that a similar re-mixing might take place with ethylamine and water.

Prof. SILVANUS P. THOMPSON recalled the experiments of Prof. Ramsay on the critical states described by Andrews, and the failure of a body beyond the critical condition to retain in solution the substances it held as a liquid.

Mr. W. LANT CARPENTER suggested the microscopic examination of the tri-ethylamine and water mixture at its critical temperature.

Members then visited the College rooms.

CORRESPONDENCE.

ENSILAGE.

To the Editor of the Chemical News.

SIR,—The paper on ensilage by Mr. F. J. Lloyd in the CHEMICAL NEWS, vol. xlix., p. 210, contains some valuable suggestions, and should assist in elucidating a very difficult and complicated subject.

Mr. Lloyd bases his arguments upon some analyses of the grass put in, and the silage taken from the experimental silo constructed by Lord Egerton at Tatton Park, the results of which were contained in a paper of mine published in the *Journal of the Royal Agricultural Society*. In that paper I limited my observations to a plain statement of facts, and left the figures to speak for themselves, but in a paper lately published in the *Journal of the Royal Manchester, Liverpool, and North Lancashire Agricultural Society*, I have entered more fully into the chemistry of the subject, and have drawn such conclusions as I believe are warranted by the facts of the case. Under these circumstances I may perhaps be allowed to offer a few words of explanation and correction with regard to Mr. Lloyd's paper.

The grass which I analysed was pitted in July 4, and its position carefully noted. The filling was performed as follows:—

Total acreage mown, July 4..	$2\frac{1}{2}$
,, ,, ,, ,, 5..	$1\frac{1}{2}$
,, ,, ,, ,, 27..	$1\frac{1}{4}$
	$5\frac{1}{4}$

having a total weight of 16 tons 11 cwts. 2 qrs. 22 lbs., including 2 cwts. 2 qrs. 16 lbs. of salt. On July 14 the

grass level was 8 ft. 6 ins., showing a shrinkage of 4 ft., and it subsequently sank still further. From the data obtained it was calculated that the grass, from which the sample originally analysed was taken, would be found at a distance of about 1 ft. 6 ins., from the bottom, and to avoid error two samples of silage, one taken from between 1 ft. and 1 ft. 6 ins. from the bottom, and the other from between 1 ft. 6 ins. and 2 ft., were analysed. The sample taken from the bottom layer was analysed to determine to what extent the excess of water had influenced the quality and the nature of the fermentation, and not with a view of ascertaining the composition of the bulk of the silage. It is clear, therefore, that any comparisons which are made between the analyses of the grass and the silage must be limited to those samples taken from the two upper layers just indicated, and must not include the wet and spoiled bottom layer, of which no analysis was originally taken. Mr. Lloyd has, however, based his calculations upon the assumption that the silo was only 2 ft. deep, and that it is, therefore, necessary to include the bottom layer. He has further multiplied the analysis of this wet and spoiled portion by 2, in taking the average composition of the silo. No doubt such a proceeding would be perfectly justifiable if the silage had only occupied a depth of 2 ft., but as it finally stood at a height of about 9 ft., such a calculation is misleading.

Mr. Lloyd asks for an explanation of the increase in mineral matters. With regard to the increase found in my experiments, the explanation appears to me obvious. As stated above, 2 cwts. 2 qrs. 16 lbs. of salt were used in the preparation. The heavy pressure on the surface would express a portion of the juices from the grass, and this expressed juice would sink to the bottom of the silo, bringing with it a considerable portion of salt, so that the upper portion would contain less than the bottom. At Tatton Park this was proved to have occurred by the liquid which separated. As the samgles of silage were taken from a part comparatively near the bottom, the excess of mineral matters is easily accounted for—as I found the excess to be due to salt. It is obvious that only the total amount of mineral matters put into the silo could be taken out, and that if an increase in percentage occurs, it must be due either to loss of water or organic matter, or to a shifting of position. The weight of the silage, compared with the weight of the grass pitted, showed that only a trifling loss had occurred, and we may, therefore, safely assume that the explanation just given is the correct one, more especially as it was confirmed by the direct results of the analyses. It seems to me probable that a similar action might occur during ensilage, even when conducted without the addition of salt. During the process, lactic, acetic, and other acids are formed, which, filtering through the silage, might readily dissolve a portion of the mineral matters contained therein, and thus produce the apparent anomaly mentioned by Mr. Lloyd.

By including the wet bottom layer in the composition of the silage the percentage of mucilage, sugar, &c., is reduced, and consequently the loss is exaggerated, while, instead of a gain in indigestible woody fibre, there is a slight loss, or, more correctly speaking, a diminution.

I would also point out that the calculations made by Mr. Lloyd are based upon the determination of nitrogen in the grass and silage. In the grass (dried at 100° C.) I found 1·60 per cent nitrogen, and in the silage (also dried at 100° C.) 1·54 and 1·56 per cent nitrogen. After making correction for the salt contained in the samples, these figures are equal to :—

	Per cent Nitrogen.
Dried grass	1·60
Dried silage (without salt)	1·68
" " " " (2nd sample) ..	1·66

Showing an average gain of only 0·07 per cent. The determinations were made with every possible care, and, I doubt not, represent the truth as nearly as the method will permit, but I must offer a protest against making absolute calculations on so slender a basis. Besides the loss by fermentation, there was a loss by the solvent action of the expressed juices, and the data are not sufficiently definite to determine what loss must be attributed to fermentation and what to drainage. The total loss, however, is comparatively small, and is, I believe, fully covered by the 6 per cent calculated by Mr. Lloyd, but his separate results are apt to convey an erroneous impression, and to under-estimate the feeding-value of silage.

It, however, seems quite clear that the conversion of indigestible fibre to soluble compounds, so much talked about, has been greatly over-estimated, and it seems probable that the general conclusions of Mr. Lloyd in this respect are correct. It is also clear that the loss of substance by fermentation has, by many, been greatly exaggerated.

The most important result of my investigation is undoubtedly the direct proof that in ensilage a considerable proportion of the insoluble albumenoids are rendered soluble.—I am, &c.,

Alfred Smetham, F.C.S., F.I.C.,
Consulting Chemist to the Royal Manchester, Liverpool, and North Lancashire Agricultural Society.

Analytical Laboratory, 18, Brunswick Street,
Liverpool, May 12, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 14, April 7, 1884.

Specific Heats of Water and of Carbonic Acid at Very High Temperatures.—MM. Berthelot and Vieille.—The mean specific heat of watery vapour increases very slowly with the temperature, according to the formula $16{\cdot}2+0{\cdot}0019\,(T-2000)$. The mean specific heat of carbonic anhydride is increased more than threefold from 0° to 4300°, and the elementary heat is quadrupled.

Application of Faraday's Law to the Study of the Conductivity of Saline Solutions.—E. Bouty.—The law which the author has announced with relation to the electric condectivity of saline solutions may be extended to the salts with several equivalents of acid, to the double salts, and to the salts of the polybasic acids. It is merely requisite to know in what manner the salt is electrolysed, and what is the quantity of the salt equivalent to KCl. Certain double salts do not exist in dilute solutions, and behave like simple mixtures; such are the double sulphates of cobalt and ammonium, of nickel and ammonium, &c. Other double salts preserve their individuality in the most dilute solutions, such as potassium bichromate and sulphocyanide, and magnesium platino-cyanide.

New Experiments on the Liquefaction of Hydrogen. Solidification and Critical Pressure of Nitrogen.—K. Olszewski.—The use of hydrogen as a thermometric material for measuring low temperatures is the only rational and practical method. The author liquefied nitrogen by a pressure of 60 atmospheres and a temperature of −142°. Its critical pressure is 39·2 atmospheres.

Duration of the Transformation of Superheated Octahedral Sulphur into Prismatic Sulphur. — D. Gernez.—The study of the circumstances of the transformation of octahedra into prisms, under the influence of a prismatic crystal, shows that the crystals of sulphur of an octahedral form, produced under different circumstances, are not physically identical.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 4, 1883.

Behaviour of Uric Acid with Glycerin.—G. Colasanti.—Warm glycerin is one of the best solvents for uric acid.

Behaviour of Biliary Acids with Albumen, Hemialbumose, and Peptone.—Taurocholic acid precipitates albumen but not peptone, and thus serves for the separation of these bodies.

Behaviour of Biuret and Albumenoids with Solution of Copper and Alkali.—On dissolving copper hydroxide in an alkaline solution of biuret there are formed flat prismatic crystals which appear red if viewed on their flat surfaces, but yellowish green on their edges.

Acidified Solution of Sodium Chloride as a Reagent for Albumen in Urine.—W. Roberts.—A solution of 1 part sodium chloride in 2½ parts water, to which is added 5 per cent of hydrochloric acid of sp. gr. 1·052 precipitates albumen from urine.

The Optical Methods for the Determination of Hæmoglobine.—E. Branly.—This paper does not admit of useful abstraction.

The Distribution of Poisons in the Organism in Poisoned Persons.—C. Bischoff.—From the *Berichte der Deutsch. Chem. Gesellschaft*, under which it will be noticed.

Detection of Morphine in Corpses.—H. Warnecke.—The author finds that morphine, like other alkaloids, resists prolonged digestion with pepsin, pancreatin, putrescent animal matter, &c.

Pyridine in Commercial Amylic Alcohol. — L. Haitinger.—The author finds as much as 0·1 per cent of pyridine, besides other bases in amylic alcohol,—impurities which in toxicological cases may mislead the expert. The amylic alcohol should be shaken up with an acid and re-distilled before use.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xiii., Part 2.

The Influence upon Soils and Crops of Water containing Sodium Chloride and Zinc Sulphate.—Dr. F. Storp, Prof. J. Konig, and others.—It appears that the water of even large brooks may, without animal contamination, contain as much as 2 to 3 grms. sodium chloride per litre. It was found that a solution of this salt exerts a far greater solvent power upon plant-foods than does pure water, the action increasing with its concentration. This fact had been previously established by the researches of De Luna and Terreil as far as the phosphates of the alkaline earths and the silicates of potash and lime. Calcium sulphate and carbonate and magnesium carbonate were decidedly more soluble in solution of common salt than in pure water, with partial double decomposition. As a manure, sodium chloride is only exceptionally useful, as dressings with gypsum and marl produce the same effects without the accompanying dangers. Upon vegetation the action of salt was found injurious, in proportion to the concentration of the solutions. The quantities required to do injury will rarely occur in practice. The germination of seeds and the development of young plants are also interfered with by solutions of salt. The action of zinciferous waters both upon soil and plants is decidedly more injurious. Zinc sulphate occurs both in flue-dust and in the residue from the lixiviation of the ores. Zinc oxide is absorbed by the soil like potash and lime. The salts of zinc, as it might be expected, prevent the decomposition of organic matter and its passage into an assimilable condition. The basic mineral constituents of plant-food are removed from the soil, and in their place zinc and sulphuric acid are absorbed. Upon germinating seeds zinc sulphate has little injurious action in the dark, but on their exposure to light it acts as a violent and rapid poison. Water containing 0·05 grm. per litre proved fatal to willow trees.

The Production of Farm-yard Manure and its Cost.—Prof. Holdefleiss and M. Herter-Burschen.—The authors contend, on analytical evidence, that dung, allowed to remain under the animals in the various stalls, &c., is better in quality than such as is daily removed. They hold, also, that the health of the cattle is not impaired. The cost of the manure produced is 48s. yearly per cow; or 4s per ton.

Manuring with Common Salt and the Refuse of Herrings.—E. Hequet d'Orval and A. Pagnoul.—The herring-refuse contained per cent 1·26 nitrogen, 1·19 phosphoric acid, but sodium chloride 52. The crops were poor, as might be expected.

Carnallite as a Cheap Substitute for Kainite.—Dr. Tooschke.—Kainite is readily capable of absorbing 4·5 per cent of ammonia, whilst carnallite takes up double the quantity, and is therefore preferable for sprinkling in stables and over dung-heaps. Caution is recommended in its application to beets and potatoes.

Kainite and Bone-Meal on Sandy Soils.—F. W. Steffens.—The results of 3 cwts. kainite, followed up by 1 cwt. bone-meal, gave satisfactory results. The application of 1 cwt. bone-meal in former years, without kainite, had proved apparently useless.

Manurial Experiments with Sea-Mud and Moor-Composts.—H. Enckhausen.—Both with rye and oats the sea-mud gave much better results than an equal weight of farm-yard manure. The results were, with the mud, 2500 parts of grain as against 1833 with farm-yard manure and 1500 on a similar plot of unmanured land.

The Formation of Peptone, and its Re-conversion into Albumen.—A. Pœhl.—From the *Berichte der Deuts. Chem. Gesellschaft.*

MEETINGS FOR THE WEEK

Monday, 26th.—Society of Arts, 8. "Fermentation and Distillation," by Prof. W. Noel Hartley.
Tuesday, 27th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.
— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.
Wednesday, 28th.—Society of Arts, 8. "Primary Batteries for Electric Lighting," by I. Probert.
— Geological, 8.
Thursday, 29th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Society of Arts, 8. "Some Economical Processes connected with the Woollen Industry," by Dr. William Ramsay.
— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
Friday, 30th.—Royal Institution, 8. "Sur les Couleurs," by M. E. Mascart, at 9.
— Society of Arts, 8. "Street Architecture in India," by C. Purdon Clarke, C.I.E.
Saturday, 31st.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.

TO CORRESPONDENTS.

V. A. Wright.—Consult some standard work on chemical physics.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1279.

CHLOROPHYLL PROBABLY A COMPOUND OF IRON WITH ONE OF THE GLUCOSIDES.

By Dr. A. B. GRIFFITHS, F.C.S.,
Membre de la Société Chimique de Paris, &c.

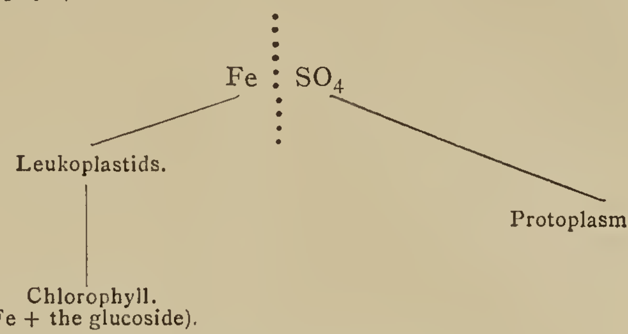
MANY chemists and other scientific men have been working of late on the constitution of the green colouring matter of plants. The latest researches are those of Dr. Edward Schunck, F.R.S. (*Proceedings of the Royal Society*, vol. xxxvi., p. 183). In these interesting researches he shows that most probably chlorophyll is a glucoside. He makes an extract of leaves in boiling alcohol; the extract is allowed to settle, and then filtered; the deposit on the filter is mixed, and shaken up with its own volume of ether and with about two volumes of water. The liquid then divides into two strata—the upper green one (*a*) which Dr. Schunck says contains all the chlorophyll, and a lower yellow one, which contains tannic acid, a yellow colouring matter, a substance giving a glucose reaction with Fehling's solution (this glucose, I venture to say, is derived from the protoplasm of the plants, for I have found glucoses* in the protoplasm of living and dead cells of *Spirogyra*). Dr. Schunck now separates the two liquids, and the upper one is shaken up with a fresh quantity of water and ether until the lower layer does not give the glucose reaction. The upper liquid leaves on evaporation a green residue. If this residue be dissolved in alcohol and treated with sulphuric acid, and the alcohol evaporated off, then on adding Fehling's solution the glucose reaction is produced; thus proving that green leaves of all plants contain a glucoside, and that this glucoside, says Dr. Schunck, is very likely chlorophyll.

Now, by taking some of Dr. Schunck's green residue from the upper liquid (*a*), already referred to, dissolved in alcohol, and adding a solution of potassium ferricyanide, a blue colour was produced, most probably indicating the presence of iron.

In a previous memoir (*Transactions of the Chemical Society*, 1883, p. 195, and the *Journal of the Royal Microscopical Society*, 1883, p. 536) I have shown the existence of crystals of ferrous sulphate in close proximity to the chlorophyll granules of certain plants. It is most probable that *iron* enters into the constitution of green chlorophyll; perhaps it is a complex molecule of iron and this glucoside of Schunck. We know that no green coloured chlorophyll is produced in plants growing in soils, solutions, or other media deprived of iron. Iron, therefore, plays a most important part in the life of all plants: indirectly it is the means of the process of assimilation taking place, and also the manufacture of starch, sugars, gum, cellulose, &c., in the cells of plants.

From my already published researches† on the value of ferrous sulphate as a manure, I may say that the *iron* acts most probably as the food for the chlorophyll granules, and the *sulphur* as the food for the protoplasm of the cells, &c.; for I have grown plants to maturity in a solution containing all the inorganic salts requisite for plant life. But the whole of the sulphur in solution was in the form of sulphate in combination with dyadic iron, and not in combination with calcium or sodium; thus showing that the sulphur of the ferrous sulphate (my new manure) nourishes or acts as a food for the protoplasm or the albuminous parts of the vegetable organism, for I have found that plants will not grow if entirely deprived of sulphur in some form or other.

From my recent work on this subject it is not improbable that in the chlorophyll cells the molecules of ferrous sulphate which are taken up by the roots are constantly being decomposed, the iron combining with the colourless variety of this glucoside (*i.e.*, the leukoplastids of the vegetable physiologist), forming the green glucoside (chlorophyll):—



and the sulphur going to nourish the protoplasm.

Probably this or similar metamorphoses continue throughout the life of the plant, for, as Liebig says,—"Vitality is the power which each organ possesses of constantly reproducing itself, and for this it requires a *supply of substances* which contain the constituent elements of its own substance and are capable of undergoing transformation."

* "Notes on Loew and Bokorny's Researches on the Probable Aldehydic Nature of Albumin," CHEMICAL NEWS, vol. xlviii., p. 179; *Journal of the Royal Microscopical Society*, April, 1884, p. 249; *Journal of the Chemical Society*, 1884 (abstracts), p. 202.

† "Experimental Investigations on the Value of Iron Sulphate as a Manure for certain Crops," *Transactions of the Chemical Society*, 1884, pp. 71-75; and the *Evening Telegraph of Philadelphia, U.S.A.*, March 8, 1884.

ATOMATION OF OXYGEN AT ELEVATED TEMPERATURES, AND THE PRODUCTION OF HYDROGEN PEROXIDE AND AMMONIUM NITRITE, AND THE NON-ISOLATION OF OZONE, IN THE BURNING OF PURIFIED HYDROGEN AND HYDROCARBONS, IN PURIFIED AIR.*

By ALBERT R. LEEDS.

IT has heretofore been established, by the fact of the conversion of carbon monoxide into dioxide during the slow oxidation of phosphorus, that the formation of ozone, hydrogen peroxide, and ammonium nitrite, in the course of this eremacausis, is preceded by the resolution of the oxygen molecule into its constituent atoms. The converse of this proposition, viz., that when oxidation occurs with the contemporaneous formation of the three products enumerated, this oxidation has been preceded by the production of atomic oxygen, has not as yet been satisfactorily established, and awaits experimental proof.

The object of this second paper is to present the conflicting testimony as to whether these three bodies are formed during the rapid combustion of hydrogenous substances, and the results of a new experimental inquiry.

According to Schönbein, the formation of ozone occurred in all cases of slow oxidation in presence of atmospheric air. Moreover, that when readily oxidisable metals, like zinc and iron, were agitated in contact with air and water, hydrogen peroxide was formed. Also, that ozone, in presence of air and moisture, would generate ammonium nitrite.

This last statement, after long controversy, has been satisfactorily disproved by Carius.* Satisfactorily, because Berthelot† working independently and at a later period, has

* Reprinted from the *Journal* of the American Chemical Society, Nos. 1-2, Jan.-Feb., 1884.

* *Ann. der. Chem.*, clxxiv., 31.

† *Comptes Rendus*, lxxxiv., 61.

entirely confirmed the results obtained by Carius. It has thus been established beyond reasonable doubt, that ozone in presence of moist atmospheric air or moist nitrogen will generate neither ammonium nitrite or nitrate.

At the same time it is no less certain that in the slow oxidation of phosphorus the contemporaneous formation of ammonium nitrite, ozone, and hydrogen peroxide takes place. And whilst the observations of Schönbein and others, as to the occurrence of the same phenomena in the course of the slow oxidation of metals, have not been re-investigated with the same minuteness as the oxidation of phosphorus, yet it is eminently probable that the correctness of his labours in these particulars will be eventually vindicated. In this connection, the recent controversy and final establishment of the fact of the production of both hydrogen peroxide and ammonium nitrite, when the hydrogen in palladium hydrogen undergoes slow oxidation in presence of air and moisture, is very instructive.

After the researches of Marignac, Andrews, Soret, Brodie, and others had elucidated the true nature of ozone, a very different interpretation was put upon many of the experimental results obtained by Schönbein from that put forth by their original observer. Instead of regarding, as Schönbein did, ozone or the fictitious antozone, as the starting point in certain sequences of phenomena, the hypothesis was advanced in various quarters that the real starting point was an initial change in the oxygen molecule, necessarily antecedent to all the observed phenomena.

In any new investigation of this topic it is but just to previous observers to rehearse the history of their labours, and in so doing the difficulties encountered are of two kinds:—1st. To ascertain in regard to particular experiments whether the reactions noted were in reality due to their ascribed causes. 2nd. To re-state the theoretical explanation of these phenomena in the light of the present universally received doctrines concerning the true nature of ozone.

One of the earliest observations relating to the subject matter of the present paper was that contained in a brief communication made to the Lyceum of Natural History of New York in 1869, by Loew.* His experiment was of a very simple nature. He blew a strong current of air through a fine tube into the flame of a Bunsen's burner, and collected the air in a beaker glass or balloon. He stated that in the course of a few seconds, sufficient ozone could be collected in this manner to be identified by its intense odour and the common tests.

Subsequently, a large apparatus containing many jets and burners was patented by Loew and applied to the mellowing of whiskies by means of the "ozone" thus formed.†

The production of ozone in the manner described was immediately denied by Boeke, who substituted a blast of oxygen for the air expired from the lungs, and obtained from the gaseous products the reactions and odour of a compound of nitrogen and oxygen.‡

Böttger likewise denied the accuracy of Loew's results, but upon altogether different grounds.‖ He detected no ozone in air blown through the flame of a Bunsen burner, but ammonium carbonate (which he regarded as a regular constituent of air expired from the lungs), and hydrogen peroxide. In reply to these criticisms Loew repeated his experiments, using instead of expired air a bellows and a large Bunsen burner, and stated that in this manner he filled, in a short time, a large room with the peculiar odour due to ozone, while delicate tests failed to detect any peroxide of hydrogen or ammonium carbonate.

Similar experiments were performed by Than.§ This observer aspirated the products of combustion from the lower edge of the flame of a Bunsen burner through an acidulated solution of potassium iodide and starch. A blue colouration was speedily produced, the air in the wash-bottle smelling distinctly of ozone. When pure water was used as an absorbing solution and subsequently tested with potassium iodide and starch, no blue colour was developed. From this negative result the absence of ammonium nitrite was inferred, and from the previous affirmative result the presence of ozone. But the formation of ammonium nitrite as a product of combustion of hydrogen has since that time been established beyond doubt, whilst the reactions for ozone obtained by Than permit of other explanations.

Similar objections apply to the experiments performed by Struve (1871),* who endeavoured to prove that ozone, hydrogen peroxide, and ammonium nitrite are all present in the products of combustion of hydrogen. The gas was burned beneath a long drawn-out funnel, and tests were made for ozone at the upper end of the funnel, whilst the water condensed on its sides was collected and examined for hydrogen peroxide and ammonium nitrite.

In *Poggendorff's Annalen* for 1872 (p. 480), a summary is given of the results obtained by Pincus upon the formation of ozone, when thoroughly purified hydrogen gas was burned in atmospheric air. The gas was burnt with the smallest possible lens-shaped flame from a metal jet. According to Pincus, when a cold and clean beaker glass was held over the flame the contents of the beaker possessed as powerful an odour of ozone as the interior of a charged Leyden jar. When pure oxygen was substituted for the atmospheric air in a properly constructed apparatus, the same phenomena occurred, showing that the nitrogen of the air was not essential to its development.

The merit of having established, by rigorous experimental proof, the formation of ammonium nitrite by the burning of hydrogen thoroughly purified in thoroughly purified air, is due to Zoeller and Grete.† In their apparatus the air and hydrogen were purified by passage through potassium permanganate, potash, sulphuric acid, and Nessler's reagent, and the absence of both nitrous acid and ammonia in the gases prior to combustion most carefully demonstrated. The hydrogen was burnt in a jet 3 to 4 m.m. high issuing from a platinum blowpipe tip. The ammonia formed by combustion was converted into ammonio-platinum chloride, the nitrous acid was identified by diamido-benzole and other tests. Nitric acid was sought for, but no reaction for it was obtained. The authors make no mention of either ozone or hydrogen peroxide.

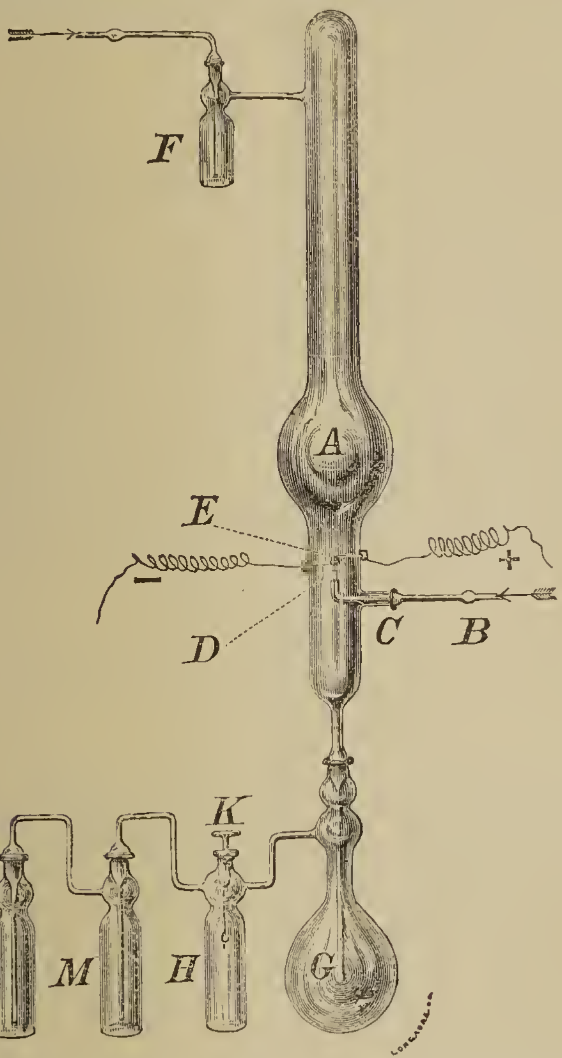
In entering upon the present investigation of this difficult topic, it was with the hope of constructing an apparatus in which, by the use of completely purified gases, and the elimination of all surfaces of contact with organic bodies, it would be possible to decide whether at one and the same time, ozone, hydrogen peroxide, and ammonium nitrite (and possible nitrate) were formed in process of combustion of hydrogenous substances.

The apparatus employed is figured in the accompanying cut. The combustion chamber A consists of a tall glass cylinder 80 c.m. in height and 6 c.m. in diameter, with a globular enlargement. At the bottom it connects, by a tube passing through a stopper of ground glass, with the receiving vessel, G. This vessel communicated with the bottle, H, whose stopper, K, is provided with a platinum hook fused in to its lowest part. H communicates with the wash-flasks, M and N, by tubes passing through their mouths and ground into them air-tight. The entrance tube, B, passes through the ground glass joint, C, and is fused to the platinum jet, D. Platinum wires connected with a coil are twisted into a very small spiral E, which is interrupted so as to allow of the passage of a spark immediately above the jet. At the upper portion of the chamber, A, there is a lateral tube connected with a wash-flask, F, which is provided with an entrance-tube passing through its stopper of ground glass.

* Chemical News, xxii, 13.
† *Wagner's Jahresb.*, 1874, p. 404; *Dingl. Polyt. Journ.*, ccxiii, 306
‡ Chemical News, xxii., 24.
‖ *Chem. Centr.*, 1870, p. 161.
§ *J. pr. Chem.* [2] i., 415.

* *Zeitsch. Anal. Chem.*, x., 292.
† *Ber. Bericht.*, x., 2144.

In the performance of the experiments the air, after passage through a long tube filled with ignited asbestos, was passed through water, potassium permanganate, potash, sulphuric acid, and Nessler's reagent, entering at the upper end of the combustion chamber by the wash-flask, F. It encountered the hydrogen similarly purified at E, and combustion was brought about by passage of the spark at this point. The platinum spiral was made very small so as to be contained within the outer surface of the flame. This was done to obviate the possible error dne to the contact of platinum at high temperatures with the mixed gases. At the same time some device of this character was necessary, since the perfectly purified hydrogen gave an invisible flame and it could not be certainly known, except by the incandescence of the platinum, whether the flame had gone out or not. Without the platinum, extinction of the flame was very apt to occur, but with the platinum this never happened. The products



of combustion flowed down into G, in which vessel and in H and M they were entirely condensed, these vessels being kept cold by ice. N contained a solution of potassium iodide, free from iodate and other impurities.

On opening the apparatus, in none of the trials was the odour of ozone noted. The potassium iodide alone, or after addition of starch water, was never effected when pure hydrogen was burned. When illuminating gas was used, the potassium iodide soiution gave no indications of decomposition by ozone on application of tests. If starch was added to it, a faint reddish precipitate was formed. On filtering off this precipitate, washing thoroughly with water, and allowing it to remain in contact with air, it became violet in colour. Unfortunately the amount was so small that the nature of this yellow precipitate could not be determined with certainty. Aldehyd, passed into a solution of potassium iodide starch, yielded a yellow precipitate, turning first violet and then blue on exposure to air. But these experiments are apart from the main purpose of the investigation and the deportment of potassium iodide alone or with starch sufficiently established the fact that no ozone passed through the wash bottle, N.

The condensed water gave an intense reaction with the Griess's tests. When pure hydrogen was used the percentage of nitrous acid was 0·005 part in 100,000, that of ammonia 0·002 part per 100,000. These quantities are in the proportion corresponding to ammonium nitrite. The amount of hydrogen peroxide much exceeded that of ammonium nitrite, being 17 parts per 100,000. The various tests for hydrogen peroxide in which potassium iodide enters as one of the constituents were not relied upon as conclusive, since the results obtained might have been due to other substances possibly present. But the condensed water gave in addition an intense blue colour with fresh cold extract of malt and fresh guaiacum tincture. Moreover, it developed with solution of chromic acid a strong blue colour, the last being regarded as the most satisfactory of the tests applied to prove qualitatively the presence of hydrogen peroxide. No nitric acid was detected.

The amounts of nitrous acid, ammonia, and hydrogen peroxide obtained when purified illuminating gas was burned, were not determined, but the qualitative tests applied to establish their presence were the same as those used in the case of pure hydrogen and were equally satisfactory.

It should be observed that an apparatus of the character described is not well adapted to settle the question of the possible formation of ozone. The products of the combustion could not be rapidly withdrawn from the influence of the elevated temperatures in the immediate vicinity of the flame, and any ozone formed could readily have undergone decomposition. The experiment is a failure, in so far as its bearing upon the validity of the observations made by preceding observers is concerned. In all their experiments the immediate withdrawal of the products of combustion is an essential feature. In repeating their experiments, if other evidence than that afforded by the powerful odour of ozone is sought for, it would be necessary to obtain the absorption spectrum of ozone and the blackening of silver. Under the conditions of the experiment, other qualitative tests for the presence of ozone would be open to question. The amount of ozone necessary to yield these decisive proofs, however, is much greater than that which could possibly be obtained in any trial where all the essential precautions are observed. For these reasons further experiments are abandoned.

The final conclusion reached is the *certain formation* of hydrogen peroxide and ammonium nitrite, and, in view of the fact that the statements of others concerning the presence of ozone have not been disproven, the *possible formation* of ozone.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

BISMUTH.

EARLY in the century the combining weight of bismuth was approximately fixed through the experiments of Lagerhjelm.† Effecting the direct union of bismuth and sulphur, he found that ten parts of the metal yield the following quantities of trisulphide:—

12·2520
12·2065
12·2230
12·2465

Mean 12·2320

* Smithsonian Miscellaneous Collections. "The Constants o Nature."
† *Annals of Philosophy*, 4, 358. 1814. Results adopted by Berzelius.

Hence B=215 in round numbers, a value now known to be much too high. Lagerhjelm also oxidised bismuth with nitric acid, and, after ignition, weighed the trioxide thus formed. Ten parts of metal gave the following quantities of Bi_2O_3:—

11·1382
11·1275

Mean 11·13285

Hence, if O=16, Bi=211·85, a figure still too high.

In 1851 the subject of the atomic weight of bismuth was taken up by Schneider,* who, like Lagerhjelm, studied the oxidation of the metal with nitric acid. The work was executed with a variety of experimental refinements, by means of which every error due to possible loss of material was carefully avoided. For full details the original paper must be consulted; there is only room in these pages for the actual results, as follows. The figures represent the percentages of Bi in Bi_2O_3:—

89·652
89·682
89·644
89·634
89·656
89·666
89·655
89·653

Mean 89·6552 ± 0·0034

Hence Bi=207·523 ± 0·082; or, if O=16, Bi=208·001.

Finally, we come to the results obtained by Dumas.† Bismuth trichloride was prepared by the action of dry chlorine upon bismuth, and repeatedly rectified by distillation over bismuth powder. The product was weighed in a closed tube, dissolved in water, and precipitated with sodium carbonate. In the filtrate, after strongly acidulating with nitric acid, the chlorine was precipitated by a known amount of silver. The figures in the third column show the quantities of $BiCl_3$ proportional to 100 parts of silver:—

3·506 grms. $BiCl_3$	= 3·545 grms. Ag.	98·900
1·149 ,,	1·168 ,,	98·373
1·5965 ,,	1·629 ,,	98·005
2·1767 ,,	2·225 ,,	97·829
3·081 ,,	3·144 ,,	97·996
2·4158 ,,	2·470 ,,	97·806
1·7107 ,,	1·752 ,,	97·643
3·523 ,,	3·6055 ,,	97·712
5·241 ,,	5·361 ,,	97·762
	Mean	98·003 ± 0·090

Hence Bi=210·464 ± 0·294.

The first three of the foregoing series of experiments were made with slightly discoloured material, and may therefore be rejected. The remaining six percentages give a mean of 97·791; whence Bi=209·78; or, if O=16, Bi=210·26.

As between the unaccordant results of Schneider and of Dumas, those of the former chemist are probably nearest correct. His method of determination was the more reliable, and the details which he gives concerning his manipulations afford strong presumptions of accuracy. Doubtless the bismuth trichloride used by Dumas contained, like the corresponding antimony compounds, traces of oxychloride. We may fairly assume, for all practical purposes, that the atomic weight of bismuth cannot be far from 208.

The following additional note has been communicated by the author:—

Since this chapter was written, the lower value for bismuth has been confirmed by Marignac.* First, Bi_2O_3 was reduced in hydrogen; yielding, in mean of six experiments, 10·318 ± 0·0035 per cent of oxygen. Hence, if O=16, Bi=208·60. Secondly, Bi_2O_3 was converted into $Bi_2(SO_4)_3$. In six experiments, in mean, 100 parts of oxide yield 151·728 ± 0·0099 of sulphate. If S=32·06, Bi=208·16.

Using the new values for O and S found in this recalculation, Marignac's results compute as follows:—

Oxide series	Bi=208·125	± 0·085
Sulphate ,, ...	,, 207·672	0·064

These values, combined with that deduced from Schneider's work, give, in mean, Bi=207·743 ± 0·043. If O=16, this becomes Bi=208·221

Two experiments have also been published by Lowe,† who oxidised bismuth with nitric acid. His results give a mean of 10·352 per cent of oxygen in Bi_2O_3, whence, if O=15·9633, Bi=207·362.

TIN.

Stannic oxide and stannic chloride are the compounds which have been studied in estimating the atomic weight of tin.

The composition of stannic oxide has been fixed in two ways; by synthesis from the metal, and by reduction in hydrogen. For the first method we may consider the work of Berzelius, Mulder and Vlaanderen, and Dumas.

Berzelius‡ oxidised 100 parts of tin by nitric acid, and found that 127·2 parts of SnO_2 were formed.

The work done by Mulder and Vlaanderen‖ was done in connection with a long investigation into the composition of Banca tin, which was found to be almost absolutely pure. For the atomic weight determinations, however, really pure tin was taken, prepared from pure tin oxide. This metal was oxidised by nitric acid, with the following results. 100 parts of tin gave of SnO_2:—

127·56—Mulder.
127·56—Vlaanderen.
127·43— ,,

Mean 127·517 ± 0·029

Dumas§ oxidised pure tin by nitric acid in a flask of glass. The resulting SnO_2 was strongly ignited, first in the flask, and afterwards in platinum. His weighings, reduced to the foregoing standard, give for dioxide from 100 parts of tin the amounts stated in the third column:—

12·443 grms. Sn	gave 15·820 SnO_2.	127·14
15·976 ,,	20·301 ,,	127·07
	Mean	127·105 ± 0·024

In an investigation later than that previously cited, Vlaanderen¶ found that when tin was oxidised in glass or porcelain vessels, and the resulting oxide ignited in them, traces of nitric acid were retained. When, on the other hand, the oxide was strongly heated in platinum, the latter was perceptibly attacked, so much so as to render the results uncertain. He therefore, in order to fix the atomic weight of tin, reduced the oxide by heating it in a porcelain boat in a stream of hydrogen. Two experiments gave Sn=118·08, and Sn=118·24. These, when O=16, become, if reduced to the above common standard,

127·100
127·064

Mean 127·082 ± 0·012

* *Poggend. Annal.*, 82, 303. 1851.
† *Ann. d. Chim. et de Phys.*, (3), 55, 176. 1859.

* *Arch. des Sci. Phys. et Nat.* (3), 10, 10. 1883.
† *Zeit. Anal. Chem.*, 22, 498.
‡ *Poggend. Annal*, 8, 177.
‖ *Journ. f. Prakt. Chem.*, 49, 35. 1849.
§ *Ann. Chem Pharm.*, 113, 26.
¶ *Jahresbericht*, 1858, 183.

We have now four series of results showing the quantity of SnO_2 formed from 100 parts of tin. To Berzelius's single value may be assigned the probable error of a single experiment in Mulder and Vlaanderen's series :—

Berzelius	127·200	± 0·041	— Oxidation.
Mulder and Vlaanderen ..	127·517	0·029	— ,,
Dumas	127·105	0·024	— ,,
Vlaanderen	127·082	0·012	— Reduction.
General mean ..	127·143	0·0098	

Dumas, in the paper previously quoted, also gives the results of some experiments with stannic chloride, $SnCl_4$. This was titrated with a solution containing a known weight of silver. From the weighings given 100 parts of silver correspond to the quantities of $SnCl_4$ named in the third column :—

1·839 grms. $SnCl_4$	= 3·054 grms. Ag.	60·216
2·665 ,,	4·427 ,,	60·199
	Mean	60·207 ± 0·006

All these data properly combined give us the following values for the atomic weight of tin :—

From SnO_2	Sn = 117·624	± 0·050
,, $SnCl_4$	,, 117·832	0·067
General mean ..	,, 117·698	0·040

If O = 16, this becomes Sn = 117·968.

THE SPECTROSCOPIC EXAMINATION OF THE VAPOURS EVOLVED ON HEATING IRON, &c., AT ATMOSPHERIC PRESSURE.*

By JOHN PARRY, Ebbw Vale.

METALLURGISTS favoured with opportunities of observing the behaviour of metals whilst being heated or fused are of opinion that the fumes usually seen are due to the volatilisation of the metal itself or of some more volatile constituent.

In casting alloys of the more fusible metals this dissociation or volatilisation is an accepted fact, and is usually considered when adjusting the proportions of the constituents. Alloys of the more infusible metals, such as iron, manganese, nickel, cobalt, &c., have not been studied; but those who have observed the behaviour of crude iron and steel whilst being fused, or otherwise manipulated at high temperatures, have noted that, in addition to the well-known evolution of gas, fumes are given off, which has led to the inference that, as before stated, some more volatile constituent is being evolved; and Professor Ledebur asserts that as iron is being volatilised, the chemical composition of the metal may be changed, presumably, within certain narrow limits. It may be that crude iron is slowly dissociated, and certainly at the high temperature of the Bessemer process iron is volatilised, and may be seen far above the mouth of the converter, forming a red cloud, quite unlike ordinary smoke or vapour.

The spectroscopic examination of the flames issuing from blast and other furnaces show only continuous spectra, with but few lines, very similar to the spectrum of the ordinary Bunsen flame, with the exception of the Bessemer flame, which gives the carbon spectrum, together with (according to some observers) that of manganese.

I have, however, found that many of the metals are volatilised at a comparatively low temperature, but give only continuous spectra when examined in the flame. The vapour requires the intense heat of the electric spark to be passed through it to ensure complete dissociation, and consequent production of the usual line spectra. (A list of metals tested is attached hereto).

Spiegeleisen fused in a crucible evolved a fume in which I detected zinc, copper, manganese, calcium, and, with less certainty, magnesium.

Bessemer pig iron, similarly treated, gave copper, manganese, calcium, either lead or arsenic, as well as gas burning with a flame resembling that of carbonic oxide.

Bessemer pig iron burnt in a stream of oxygen at a dull red heat gave copper, manganese, &c., as before, but more intensely; also a great number of lines which appear to be derived from iron. This spectrum requires careful study, and, when developed, may throw some light on the reactions occurring during the Bessemer blow.

Spanish iron ore reduced in a crucible with charcoal, at a heat sufficient to form a button of fused metal, evolved zinc, copper, and manganese.

It is therefore probable that matter may be evolved during the ordinary heating processes in the manufacture of iron and steel, as previously explained, but giving no visible indications of the fact, in consequence of the heat being sufficient only to volatilise without effecting dissociation.

With my present limited experience, I am of opinion that the actual quantity of matter evolved from iron, steel, &c., is very small, and not at all likely to affect the quality of the coarser kinds of iron and steel, although it may be otherwise when a material of good quality and great purity is required.

The germ of the foregoing is to be found in the recent work of spectroscopists, more especially of Mr. Lockyer, who, in his "Studies in Spectrum Analysis"—a volume abounding in suggestions which should, in my opinion, be carefully studied by those practically engaged in the iron manufacture—says, "Depend upon it, that as spectroscopy becomes the daily work of ironfounders and the like, it will be found to be bristling with scientific truth which may be used in these practical applications."

Note.—Spanish iron ore evaporated to dryness with hydrocholoric acid. The dried chlorides were carefully and gradually heated in the blowpipe, and copper, zinc, calcium, barium, lead, silver, and manganese lines successively detected in volatilised chlorides. At the highest obtainable heat iron lines are seen.

The impure ferric chlorides, obtained by digesting steel or iron in hydrochloric acid and evaporating to dryness, heated as above, shows—1st, copper and calcium; 2nd, manganese; next, with less certainty, chromium and magnesium. On increasing the heat, the iron spectrum is vividly seen.

Steel or iron filings, mixed with ammonium chloride, and heated also, gives the foregoing series of spectra, which last longer, and may be repeated by successive additions of the chloride.

Very fine spectra of sulphur and phosphorus may be obtained by slightly heating either, on a moderately hot plate of iron, placed just below the spark from the coil.

Notes on the Volatility of the Metals Heated in Crucibles. Fletcher's "Injector Blowpipe" used.

Thallium ..	Very volatile. Seen in flame and spark above.
Arsenic ..	Do. Seen in spark only.
Copper ..	Do. Volatilised from most metals, in flame and spark.
Cadmium ..	Easily volatilised. Seen in spark only.
Zinc	Do. Do.
Bismuth ..	Volatilised at highest red heat. Do.
Aotimony ..	Easily volatilised. Do.
Potassium ..	Do. In flame and spark.
Sodium ..	Do. Do.
Tin	Volatilised at highest temperature of blowpipe. Spark only.
Lead	Volatilised at lower temperature than tin. Spark only.

* Continuation of previous researches on the Vapours Evolved from Iron, Steel, &c., Heated *in vacuo*.

Silver	Not volatile. Copper spectrum seen. Spark only.
Gold	Not volatile. Copper spectrum seen. Spark only.
Chromium ..	Not volatile. Copper spectrum seen. Spark only.
Manganese..	Volatilised with difficulty. Spark only.
Aluminium..	Volatile.
Selenium ..	Very volatile. Spectra require further study.
Tellurium ..	Do. Do.
Phosphorus..	Easily volatilised on hot plate. Good spark spectrum.
Sulphur ..	Do. Do.

Notes of Experiments on the Spark Spectra of the Chlorides of the Metals and Alkalies Volatilised at Atmospheric Pressure.

The chlorides of lithium, strontium, copper, and calcium are volatile in the flame of an ordinary alcohol lamp, showing the characteristic spectral lines in the spark about one inch above the flame.

Zinc, barium, copper, and magnesium chlorides are also faintly seen. Query about arsenic? Filter-paper moistened with zinc chloride and placed in the alcoholic flame gave the line W. L. 4809.

Steel filings, mixed with ammonium chloride and heated —copper and manganese first appear, next calcium, (zinc ?), next iron spectra; after heating thirty minutes only on copper and manganese two lines are seen. Iron lines nearly gone; calcium seen. Further heated thirty minutes, only calcium; traces of copper flashing out.

Spiegeleisen as above; in addition, magnesium seen; brighter spectrum throughout.

Copper chloride mixed with ammonium chloride and heated with spirit-lamp in a glass tube 20 inches long— copper distinctly seen in the spark at the top of the tube.

Impure steel chlorides, as above, heated in glass tube 4 inches long, spark at top—calcium first seen, copper, next manganese group. After heating some time, only calcium and copper were visible.

Ordinary nickel, cobalt, bismuth, tin, and antimony show copper spectrum when heated. All metals hitherto tested evolve copper.

Query zinc in steel?

Qunry magnesium in spiegel? Only first line of magnesium seen on edge of nitrogen line, W. L. 5712.

Compared this line with magnesium, by clamping cross wires down on it; magnesium line distinctly seen on edge of nitrogen, W. L. 5712.

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

May 24th, 1884.

Prof. F. Guthrie, President, in the Chair.

New member:—Mr. F. C. Phillips, electric engineer.

Prof. W. G. Adams took the chair, while the President, Dr. Guthrie, gave a brief summary of his "*Recent Researches on Eutectic Alloys*," that is, alloys of low fusing point. The complete research will be published in the Society's *Proceedings*. Dr. Guthrie showed by means of tables and cuives of results that mixtures of water and nitre, nitre and nitrates, &c., behaved in the same way as fusible alloys, such as alloys of lead and bismuth. On cooling down the alloy or mixture the ingredient present in richer quantity crystallised out. There seemed to be no definite molecular proportions in these alloys. A "tetraentectic" alloy of bismuth, 47·38; tin, 19·97; lead, 19·36; cadmium, 13·29 per cent, was exhibited by the author, which fused at 71°, or in bo'l'ng alcohol. Rose's fusible metal melts at 93°. Results were given of the behaviour of mixtures of water and the aniline salts, salicylate, oxalate, &c.; also of water and triethylamine, and other members of the ammonia group. Dr. Guthrie's observations tended to show that fusion and solution were of the same nature. He pointed out their bearing on mineralogy and geology, and inferred that water in igneous rocks was there from the first, and not by infiltration as some suppose.

The President then took the chair, and Dr. W. H. Stone exhibited a simple, cheap, and profitable Galvanometer for Hospital Use, made of a boxwood cylinder with coils wound round it, and a needle with mirror inserted into a test-tube, and pushed into the hollow of the cylinder. The needle is made dead beat by putting paraffin oil into the tube. He also exhibited a Kohlrausch Metre Bridge for Alternating Currents; a telephone playing the part of indicator. Dr. Stone employs it for measuring the resistance of the human body, which he finds to be less than 1000 ohms. With high tension currents it appears lower than with low tension currents. Another Metre Bridge of the kind with a longer wire (3 metres in this case as compared with 14 metres in the other) was also shown in connection with a sledge induction coil, by which the power of the current can be regulated to suit the patient. Dr. Stone stated that the body acts more like a solid than a liquid conductor.

Mr. Glazebrook said he had used a similar plan, with telephone, to measure the resistance of electrolytes, but found the telephone too sensitive from induction, though in Dr. Stone's work this objection might not apply.

Prof. G. Forbes stated that the telephone had been applied in a similar way to comparing capacities.

With regard to the danger from currents, Prof. Ayrton said the electromotive force of the railway current at Bushmills was 250 volts, and pointed out that very intermittent currents were more dangerous than fairly continuous ones.

Dr. Stone thought that with good skin contact (as with salt and water) this electromotive force would be dangerous.

Mr. Lecky instanced the reported death of a horse at Bushmills by a shock.

A new Speed Indicator, especially for Marine Engines, was exhibited by Mr. W. T. Goolden and Sir A. Campbell, of Blythswood. Its action depended on the rolling of a disk on a cone; the disk traversing a screw driven by the engine shaft. The disk forms the nut of the screw and rotates in an opposite direction to the latter. Its position on the screw depends on the surface velocity of the cone, which is kept turning at a uniform rate by clockwork. In travelling, the disk makes a series of electric contacts, which indicate its position on a set of dials detached. Recording apparatus can be added. The apparatus was made by Mr. A. Hilger.

Mr. W. Bailey exhibited a similar device in which the cone was replaced by a circular plane or disk. He had invented this independently, and it had the advantage of giving a zero position to the rolling disk, though the cone was the more compact arrangement. The idea of using a screw in this manner was suggested by Mr. Shaw, of Bristol, some three years ago.

The Substitution-Values of the Principal Organic Nutrients in the Animal Body.—Dr. Max Rübner.—The diet of any animal must afford one nutrient, *i.e.*, albumen, in a certain quantity; otherwise substitutions may take place within a very wide range. The author concludes that the fat in food is in equal weights isodynamic with the fat of the body. Muscular flesh consumed is for equal weights isodynamic with the albumenoid matter which is lost by the body in case o an insufficient supply. Fats and carbohydrates differ in their efficacy very widely, 100 parts of fat representing 240 parts of carbohydrates.—*Biedermann's Central-blatt für Agrikultur Chemie.*

NOTICES OF BOOKS.

The Cinchona Barks: Pharmacognostically considered. By F. A. Fluckiger, Ph.D., Professor in the University of Strassburg. Translated from the original text, with some explanatory notes by F. B. Power, Ph.D., Professor of Pharmacy and Materia Medica in the University of Wisconsin. London: J. and A. Churchill.

We have here an elaborate monograph of the trees yielding quinine and its kindred alkaloids. The author's point of view, strictly speaking, is neither that of the chemist nor of the botanist, but that of the pharmacologist. It is to be regretted, considering his high and well-merited authority, that he still sanctions the erroneous orthography "cinchona" instead of "chinchona," and doubtless the pronunciation as if the word were of Greek origin. It is a proof how little a prophetess may be honoured in her own country that the name of the Countess Chinchon can scarcely be recognised in "quinas," the Spanish term for the chinchonas. It is, however, needless to dwell on a subject which has been so ably, but, we fear, so fruitlessly discussed by Mr. C. Markham.

In the treatise before us Professor Flückiger considers firstly the botanical origin of the barks, defining them as those "containing alkaloids of a particular group, which may directly be denoted as the cinchona bases," and met with hitherto only in the barks of the *Cinchoneæ*. He notices the fact that the *Cinchona cuprea* belongs morphologically to the false, but chemically to the true barks, and conjectures that other useful barks of this class may be detected in the genera *Cascarilla*, *Remijia*, and *Pimentelia*.

In the next section follows an account of the characteristics of the most valuable species and their geographical distribution. As regards their conditions of growth the Cinchonas are somewhat peculiar. They are naturally confined to the Cordilleras, and are absent in other parts of South America which apparently afford the same physical conditions, and which are inhabited by other *Cinchoneæ*. Their range is from 10° N. to 22° S latitude, and their favourite mean temperature from 12° to 20° C. Frequent showers and mists, mingled with bright sunshine, and frequent, but not wide, changes of temperature, appear essential. Their range in altitude is from 2275 to 9425 feet—which region they indeed characterise. The attempts at the artificial cultivation of the Cinchonas in India, Ceylon, Java, Jamaica, &c., are described, and their success is fully acknowledged. The suggestion is thrown out that the so-called *Cinchona cuprea*, and probably other species belonging to the genus *Remijia*, might be successfully cultivated in hotter and drier regions. A succeeding chapter describes the collection of the wild barks in their native forests—a laborious, perilous, and not very remunerative undertaking—and the rival processes of "mossing" and "coppicing," under trial in India and Java. In the former method, invented by the late lamented Mac Iver, vertical strips of the bark are removed, about 1½ inch in width, and then covering the stem with moss, clay, or, as in Java, the Alang-alang grass (*Imperata Konigii*). It is generally maintained that the bark renews itself quickly on the denuded portions, and is richer in alkaloids than before. Prof. Flückiger, however, raises the question whether this process can be carried on for a series of years without affecting the strength of the trees? The question may also be raised whether the moss, &c., will not afford a safe *nidus* for destructive insects. In Java Moens has introduced a process of merely scraping the bark in place of entire removal. In the coppicing system, widely practised in Java and Ceylon, the stems at 8 years of age are felled at the height of 6 inches from the ground. The side shoots produced in another eight years are said to furnish a bark equally rich. The bark of the roots, formerly wasted, are found to abound in alkaloids.

Passing over the very elaborate accounts of the morphological structure of the cinchona barks, the localisation of the alkaloids in the tissues and the description of the principal commercial varieties of true and false barks, we come to the statistics of the trade. It appears that upwards of 6 million kilos. of bark are yearly brought into the market. As the average value per kilo. is 4s. to 5s., the annual cinchona harvest is worth £1,500,000 sterling.

The chemical composition of the barks is elaborately dealt with. They contain the following bases in noteworthy proportions:—Quinine, quinidine, cinchonine, cinchonidine, and in smaller amounts homo-cinchonidine, cinchonamine, homoquinine, quinamine, conquinamine, and cinchamidine. Other bases present, but differing widely in their properties, are aricine, cusconine, cusconidine, cuscamine, cuscamidine, paytine, and paricine. There are further certain amorphous bases, as yet very imperfectly known, and perhaps formed from the crystalline alkaloids during the process of manufacture.

The total quantity of alkaloids—as is proved by analytical results here given—is open to very considerable fluctuation even in the same species. De Vrij found in the bark of *Cinchona officinalis* from Ootacamund proportions of quinine ranging from 1·25 to 9·1 per cent.

As a means of detecting the presence of quinine and cinchonine in vegetable matter Grahe's process is recommended. The bark is heated with a volatile acid, organic or inorganic, when a beautiful red decomposition product is formed. Hesse has further improved upon this test by first extracting the bark to be tested with alcohol, drying up the tincture with an appropriate quantity of the powder of the same bark, and then heating as above.

For the quantitative determination of the total alkaloids and of the quinine, the methods of Squibb and of De Vrij are given in full.

The sixteenth and seventeenth chapters give the history of the barks, or rather of our knowledge of them. Curiously enough it is by no means certain whether the medicinal properties of the bark were known to the Aborigines prior to the Spanish invasion or whether they were a subsequent discovery. Humboldt notes the fact that the native Peruvians do not employ the cinchona, and even regard it with aversion, and Markham mentions that it is not employed by the native itinerant doctors. This very valuable work is illustrated with eight plates, six of which represent the species *C. succirubra*, *C. Calisaya*, *C. lancifolia*, *C. officinalis* and *Remijia pedunculata*. Plates VII. and VIII. represent transverse sections of the barks of *C. Calisaya*, *C. lancifolia*, and *C. cuprea*.

The treatise is further enriched with a very complete bibliography.

We regret that in a work emanating from a London firm of publishers of good standing a foreign orthography should have been sanctioned, and that there occur a few expressions which cannot be considered as idiomatic English.

Numerical Exercises in Chemistry. By T. Hands, M.A. F.R.A.S. London: Sampson Low, Marston, Searle, and Rivington.

This little work is one of a class which is now increasing in number. In successive chapters the author gives examples illustrative of the metric system of weights and measures, of thermometric scales, of volume, mass, density, and weight, of Boyle's law and Dalton's law of gaseous mixtures, of Gay-Lussac's law, of Graham's law of gaseous diffusion, of specific heat, latent heat, chemical equations, water, nitrogen and air, the crith, and of heat as a form of energy. Finally, come a number of miscellaneous examples, a list of elements, or at least of some of them, a set of equations representing the reactions indicated in the foregoing examples; certain tables furnishing additional exercises on the gases and answers to all the examples.

The value of this book, and of certain other works of the same type which have from time to time been noticed in our columns, depends exclusively upon the use to which

they are put. If they are employed as an adjunct to a sound laboratory training they will prove exceedingly serviceable and must command our hearty approval. If, on the contrary, they are used as substitutes for the experimental study of the science they are useless, if not positively hurtful. Useless they may be held in such case because they do not in the least contribute to cultivate the powers of observation and of drawing right conclusions from facts, which, setting all utilities and practical applications aside, are the educational advantages to be derived from a study of chemistry, or, indeed, from that of any other branch of physical science.

We must hope, however, that the book before us may be put to its legitimate uses, which are by no means trifling. It is a good omen that in it we find no reference to preparation for any examination, and no attempt to new chemistry with reference to somebody's "syllabus."

Workshop Receipts. (Third Series). By C. G. Warnford Lock. London: E. and F. M. Spon.

This volume deals principally with metallurgical and electrical subjects. The method of Webster for the improved production of aluminium is given, and whilst the valuable properties of the pure metal and of certain of its alloys are fully admitted, the extent of the economy effected by the new process is called in question, in accordance with the calculations of Mr. Weldon. He contends that Webster's improvements relate merely to obtaining anhydrous alumina from potash-alum. If his method of effecting this object were 50 per cent cheaper than that followed by Pechiney, at Salindres, it would not reduce the cost of metallic aluminium by more than 5 per cent. We believe, however, that Mr. Webster takes his stand not on the lower price but on the superior quality of the metal obtained by his method.

Mr. Weldon shows, on thermo-chemical principle, that the reduction of alumina by carbon cannot be regarded as practicable.

Under the head "Lubricants" we find a timely and judicious exposure of a common error. It is commonly supposed that the ordinary vegetable and animal oils, because they are incapable of burning without a wick, unless heated to very high temperatures, are, therefore, under all circumstances, safer than the the mineral oils. Yet both chemical theory and experience—often of a very sad nature—prove that such is not the case. A few drops of olive-oil spilt upon cotton-waste, saw-dust, &c., and thus spread out over a large surface, occasion a rise of temperature which often reaches the point of ignition. Mineral oils, even such as have a very low "flashing-point," produce no similar phenomenon, and are consequently safe, except brought in contact with a flame.

A considerable number of formulæ out of "some hundreds, if not thousands, propounded," are here quoted. One of them we notice for its singularity:—"Maguire uses for hot-neck grease tallow, 16 lbs.; fish, 60 lbs.; soapstone, 12 lbs.; graphite, 9 lbs.; saltpetre, 2 lbs. The fish (whole) is steamed, macerated, and the jelly pressed through fine sieves for use with the other constituents."

A caution is given concerning the use of mineral oils as lubricants in print-works, &c. Unless unusual care is taken they are often dropped upon the cloth and are frequently hard to remove, since they are not saponified by alkalies as are the animal and vegetable oils and fats. Mention is made of the corrosive action of the paraffin oils upon lead and zinc, whilst they do not affect tin, copper, and iron.

The utilisation of blast-furnace slag is considered at some length. One of the most plausible suggestions—its utilisation for building purposes—must be viewed with disfavour on account of the fact that the blocks are impervious to air. Hence a house built of slag will be always damp and its ventilation will be defective. Those slags which contain a tolerable proportion of phosphoric acid are now often utilised as manure, *e.g.* under Thomas and Twynam's patent. Indeed, if man could afford to wait for the slow natural process of decomposition, weathered slags, like old lavas, would form exceedingly fruitful soils.

The slag of the Creusot works is found to contain 1·92 per cent of vanadic acid, and as treated by Witz and Osmond is now one of the chief sources of vanadium compounds for use in the production of aniline blacks, &c.

It is not generally known that broken iron slags often found their way at one time into bone-ash and ground bones. If such samples were analysed by the rough and ready process of dissolving in hydrochloric acid and precipitating with ammonia, the precipitate being taken as tricalcic phosphate, this fraud was not detected.

Slag-wool, if moistened, is shown to be valueless as a non-conductor of heat, and if sulphur is present positively dangerous.

The utilisation of scrap-tin is here discussed. Many of the methods proposed are pronounced too expensive, but a favourable opinion is given of Reid's process. He oxidises the film of tin and the alloy of tin and iron immediately beneath by roasting in a specially constructed furnace, and shakes off the dust of oxides by machinery, leaving the iron in a pure state. The powder is treated with hot sulphuric acid, which dissolves the iron leaving the stannic oxide untouched. The iron sulphate is evaporated down and distilled to recover the sulphuric acid, whilst oxide of iron is left behind and is utilised as a pigment. The tin left as oxide may be smelted in the usual manner, or it might be treated with caustic soda and thus converted into preparing-salt. The waste heat from the retorts is used to assist in roasting the scraps and in evaporating down the iron sulphate.

Whilst wishing this process success we fear that it will in most cases be complicated by the presence of lead, with which the tin used in tinning iron is now largely sophisticated.

This work throughout will be a very useful manual for amateur experimentalists—now a very numerous class—and will preserve them from many tedious and costly mistakes.

The Patents, Designs, and Trade Marks Act, 1883: with Introductory Chapter, Explanatory Notes, Notes of Decided Cases; also the Practice for Obtaining Letters Patent for Inventions and the Registration of Designs and Trade Marks, with Rules, Schedules of Fees, Forms, Tables, a Complete General Index, &c. By Roger W. Wallace, Barrister-at-Law. London: W. Maxwell and Son.

The new Patent Act has of course to a considerable extent unsettled the minds of inventors and patent agents. Time must elapse before the provisions of the new system can become as familiar to persons interested as were those of the old law. Such a work as the present is, therefore, well timed and will doubtless prove of no small service. It must be borne in mind that the right interpretation of any Act of Parliament is a special art which outsiders can rarely attempt with success. The present Act has furnished an instance in point. As all the former statutes bearing on letters patent for inventions were repealed, and as in last year's Act there was no clause legalising "communications from abroad," it was very generally supposed that such "communications" were done away with. But it soon appeared that this interpretation was erroneous. The Comptroller-General of Patents—whether in accordance with or in evasion of the Act we are not qualified to decide—drew up a new form for such "communications," and they are now going on precisely as they did before. Why alien inventors should prefer this procedure to taking out directly a British patent in their own names is a mystery.

Mr. Wallace makes it his object simply to expound the law as it is, without, in general, throwing out any suggestions as to what it should be. In connection with the duties of the newly-appointed examiners he refers to one point which "must very shortly be the subject of judicial de-

cision," namely, "whether the nature of the invention has been fairly described." Concerning this same preliminary examination we are by no means satisfied. As it does not extend to the novelty of the invention there is at least room to doubt whether it can benefit either the inventor or the public. It certainly will not, as some persons have imagined, enable the inventor to dispense with the trouble of a search.

Notice is taken of the change that an English patent does not henceforth, as formerly, lapse with the expiry of any prior foreign patent for the same invention. We look, however, in vain for any explanation of the reasons which may have induced the Legislature to make this singular and apparently gratuitous alteration.

The author does not consider that an inventor has any natural property in his invention, and hence bases patent-right merely on the ground of public expediency.

The following principle is, in our humble opinion, much to be regretted:—"When letters patent have been obtained for a *new result* and the patent describes a process of arriving at that result which is effectual at the date of the patent, the patentee is entitled to protection against all other processes: it is an infringement to adopt any other process for the purpose of arriving at that result." The German law, more wisely, protects merely the particular process or processes by which the patentee arrives at his result. The reason is palpable; some other person may, to-morrow or next year, invent a much better process for obtaining the same result. According to the English law this is infringement, and consequently the public may lose the benefit of a cheaper or a better article, whilst at the same time invention is repressed. Many competent authorities hold that this very feature of the English law is one great cause of our relative decline in the manufacture of the coal-tar colours. We trust that the attention of the legislature will, at no distant date, be called to this flaw in our patent system. Indeed, this point alone gives Mr. Macfie and his supporters a powerful argument against the existence of patent right altogether.

One useful modification which has been embodied in the Act of 1883 is the provision for compulsatory licenses, in case of an alien who holds a British patent and refuses to work it in this country whilst employing the same process elsewhere. Mr. Wallace considers this a valuable provision, but seems to doubt if it will be properly carried out. Surely a provision annulling the patent on refusal to work would have been the simpler and safer expedient.

Many defects have already been pointed out in the new law, and with the sole exception, perhaps, of the provision for compulsory licenses, it becomes somewhat doubtful whether the old system was not better.

One unhappy alteration in the *Patent Office Journal*, made not in consequence of the Act, but at the good will and pleasure of the Comptroller-General, is the omission of the foreign patent lists, which formerly constituted a valuable feature.

CORRESPONDENCE.

ENSILAGE.

To the Editor of the Chemical News.

Sir,—After carefully considering where Mr. Smetham and myself seem at variance, I have decided to leave those interested in the subject to decide between us on the various points, several of which seem to me matters of opinion. Moreover, to answer the criticisms satisfactorily, as I believe I could, would take a great deal of space, more indeed than the subject justifies.

My endeavour was to calculate the whole contents of the silo. Had I noticed, as I ought, that the silage stood 9 ft. deep, I would have taken the 2 ft. layer to represent all that lay above it, and multiplied by the necessary factor. I have since done this and the results confirm my original conclusion that there was no change of so-called indigestible fibre into digestible matter. The data were not all that could be wished, but they were the most accurate obtainable, and having made the calculations for myself I thought they might help others who are working at the subject of ensilage. The explanation of the mineral matter given by Mr. Smetham may be correct, but Mr. Smetham has overlooked the fact that the layer 2 ft. from the bottom has more mineral matter in it than the bottom layer of mixed drainage and silage. To eliminate this factor my calculations were made on the organic matter only.

I hold that it is useless to draw conclusions from the analysis of any single layer of silage in a silo. The whole bulk must be taken into the calculation, without which it is impossible to say what changes take place. Mr. Smetham's analyses and criticisms are valuable, for they show that there is no uniformity of composition in the contents of a silo, and that to obtain a definite sum total of constituents will be a very difficult and complicated work. Nevertheless, I do not think that I have underestimated the feeding value of silage, and believe, in spite of Mr. Smetham's criticisms of minutiæ, the conclusion that there is no change of indigestible fibre into digestible is based upon far more accurate data than the opposite conclusion that there is such a change.—Yours, &c.,

Fredk. Jas. Lloyd.

Agricultural Laboratory,
4, Lombard-court, E.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 14, April 7, 1884.

Determination of Phosphoric Acid in Arable Soils and Rocks.—Ad. Carnot.—(See p. 216.)

Artificial Production of Fayalite.—Alex. Gorgen.—Not suitable for abstraction.

Reclamation of Priority as regards the Vitality of Virus and of Beer Yeast.—M. Melsens.—The author shows that the recent memoirs of MM. R. Pictet and Yung, and of M. P. Regnard (*Comptes Rendus*, present volume, pp. 745 and 747), have been anticipated by his papers (*Comptes Rendus*. lxx., p. 629, and lxxi., p. 73).

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xiii., Part 2.

Examination of Certain Japanese Soils.—Dr. O. Kellner and H. Imai.—Niphon, the chief Japanese island, is by no means so fruitful as it has been supposed. The character of the indigenous vegetation, the method of manuring pursued by the natives, and their disinclination to break up new land, argue a certain poverty of the soil in available plant-food. This conclusion is supported by analytical research. Both the soils and sub-soils appear rich in ferric and ferrous salts, and poor in lime.

The Synthesis of Neutral Fat from Fatty Acids in the Animal System.—Immanuel Munk.—A dog fed on meat and fatty acids, obtained from mutton tallow, was found to have accumulated in his body neutral mutton tallow.

Manurial Experiments on Potatoes at the Danzig Experimental Station.—Prof. Maercker.—A dose of manure containing more than 8 kilos. nitrogen and 10 of phos-

phoric acid per "morgen" produced no appreciable result. Nitrogen as an ammoniacal salt, in conjunction with superphosphate, acted better, both as to quality and quantity, than when given in the form of soda-saltpetre. By the addition of large quantities of potash salts in spring, the injury to quality occasioned by soda-saltpetre, so far from being compensated, was even increased. Fœcal superphosphates had a distinctly better effect, both as to quantity and quality, than a mineral manuring. The experiments were conducted on a pure "dunes"-sand, almost devoid of plant-food. On a soil which had been cultivated, but which was very light, the yield was best where the proportion of nitrogen to soluble phosphoric acid was 7 : 9½. The more these proportions were departed from, so as to approach a purely phosphatic manuring, it was less completely utilised. A dressing with potash alone was so depressing that the yield was inferior to that of the unmanured check-plot.

Experiments on Potato-manures in Ireland.—Dr. C. A. Cameron.—From the *Field*.

White Mustard as Cattle-Food,—Dr. Brummer.—The author maintains that this plant does not injure the health of cows, and improves the quality of the butter.

On Feeding Cows with Corn and Bran.—Dr. M. Schrodt and Dr. Hansen.—Admissible only when the price of corn is low.

Researches on the Influence of Heat and Light on the Development of Plants.—Prof. Hellriegal.—The optimum temperature for the various physiological functions of plants ranges between 20° and 70°; heats above 50° are destructive to the more highly organised species. The most important part of the nutrition of plants—the decomposition of carbonic acid and the assimilation of carbon in the chlorophyll-cells—is purely a function of light. In a faint light the process of assimilation is sluggish; it increases with the intensity of light, and reaches an optimum, which, however, is not the maximum point. Heat and light, together with the rainfall, form the factor of fertility generally summed up under the terms *weather* and *climate*, and it is easily intelligible that in agricultural practice they are found to determine the crops more frequently and more decidedly than the soil and the manures.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., December, 1883.

This number is chiefly taken up with the awards of prizes.

January, 1884.

Report presented by M. Jungfleisch on behalf of the Committee of Chemical Arts on a Process for the Preservation of Raw Meat, Game, and Fish for a Time not less than a Month.—The process in question, that of MM. Mignon and Rouart, depends on the application of cold. The meat in question is suddenly refrigerated to about −20°. This feature, which is of course the only novel point in the process, is to prevent the escape of fluid matters during a slow refrigeration.

February, 1884.

Manufacture of Gas from Various Residues of Distillation, Oils of Schists, &c.; Carburetted Air.—M. Felix le Blanc.—The author mentions the systems of Hirzel, of Leipzig, and Riedinger, of Augsburg. In these systems a thin stream of the oily or tarry matter is allowed to trickle into the interior of a cast-iron retort heated to dull redness, where it is converted into gas. This gas, when freed from tar, is, when obtained from certain materials, absolutely exempt from compounds of sulphur. Its illuminating power is from 2½ to 3 times higher than that of the ordinary coal-gas of London and Paris. M. Le Blanc then mentions several systems for mixing common air with the vapour of volatile hydrocarbons.

Composition of Certain Combustible Minerals.—M. Boussingault.—This paper is taken from the *Comptes Rendus*.

March, 1884.

This issue coes not contain any chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c., January and February, 1884.

This number contains no chemical matter, with the exception of certain abstracts from the *Comptes Rendus*.

Cosmos les Mondes.
No. 11, March 15, 1884.

New Use for Peat.—The upper, spongy layer of peat-beds unfit for fuel is, dried and sifted, used as a material for dry closets. One hundred parts of peat-powder render 900 parts of fœcal matter perfectly inoffensive.

MEETINGS FOR THE WEEK

Monday, June 2nd.—Royal Institution, 5. General Monthly Meeting.
Tuesday, 3rd.—Society of Chemical Industry, 8. "On the Processes concerned in the Conversion of Starch into Alcohol, and their Relation to Brewing and Distilling," by Mr. W. S. Squire.
— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.
Thursday, 5th.—Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
— Chemical, 8.
Friday, 6th.—Royal Institution, 8. "Electric Induction Experiments," by Mr. Willoughby Smith, at 9.
— Geologists' Association, 8.
Saturday, 7th.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1280.

ON THE ESTIMATION OF PHOSPHORIC ACID IN FERTILISERS.

THE OXALIC ACID METHOD COMPARED WITH THE MOLYBDIC.

By DAVID LINDO.

I have estimated the phosphoric acid with great care in seven samples of raw phosphates by the molybdic and oxalic acid methods, for the purpose of testing the accuracy of the latter method when lime and silica are present in addition to certain other bodies, such as ferric oxide and alumina, the influence of which had been previously studied.

I believe the molybdic as recently improved gives results so accurate that it may be safely taken as the standard for comparison in testing the correctness of other methods with unknown quantities of phosphoric acid.

One of the samples was from the Pedro Cays in the neighbourhood of this island; four, phosphatic earths from caves in the island; and the other two, samples of rock and earth phosphates from Nevassa.

Sample A.

From Pedro Cays; ash about 82 per cent.*

The substance consisted chiefly of calcium phosphate and carbonate. Total lime, 44·88 per cent; silica, 0·09 per cent; ferric oxide, only a trace; sulphuric acid and alumina were absent.

B.

Cave earth, ash about 49 per cent, consisting largely of calcium sulphate. The sample did not effervesce with acids. Silica, 0·99 per cent; ferric oxide, very little; alumina, if any, only a trace; operating with 0·56 grm. of the manure, only 0·002 grm. of alumina was obtained. This small quantity may have been derived from the vessels. Total lime 20·45 per cent.

C.

Cave earth, ash about 43 per cent; this sample contained much organic matter. Lime, 3·16 per cent; alumina, 11·06; ferric oxide, 7·18 per cent: sulphuric acid, 2·52 per cent; silica, 0·80 per cent. Carbonic acid was absent.

D.

Cave earth, ash about 47 per cent. Lime, 12·27 per cent; alumina, 5·02 per cent; ferric oxide, 2·27 per cent; silica, 6·88 per cent. Sulphuric acid was present, but not carbonic acid.

E.

Nevassa rock, ash about 93 per cent. Lime, 46·90 per cent, partly as carbonate; alumina, 2·18 per cent; ferric oxide, 2·7 per cent; silica, 0·85 per cent. Sulphuric acid only a trace.

F.

Cave earth, ash about 68 per cent. Lime, 27 per cent; alumina, 5·56 per cent; ferric oxide, 2·24 per cent; silica, 6·50 per cent. Sulphuric acid and carbonic acid were both present.

G.

Nevassa earth, ash about 88 per cent. Lime, 36·20 per cent; alumina, 9·95 per cent; ferric oxide, 3·27 per cent; silica, 3·33 per cent. Carbonic acid only a trace; sulphuric acid was absent.

The alumina and ferric oxide were separated according to the method recommended by Church. My experience leads me to conclude that the separation cannot be very perfectly effected by this process in the presence of much lime.

Preparation of the Samples for the Estimation of Phosphori Acid.

Bruised, mixed well, and weighed about 20 grms. into a mortar, the weight of which with pestle had been accurately taken. Kept in the balance case; carefully ground and weighed the sample from day to day until the weight was sufficiently constant to admit of accurate weighing in small quantities afterwards. Transferred to accurately ground reagent bottle, and noted the loss of weight sustained by the air-drying.

The fusion method recommended by Gilbert was adopted with all the samples. The quantity of each, air-dried, taken for a fusion was equal to 2·5 grms. of the sample in its original condition, and is shown in the following table. When much organic matter was present potassium nitrate was substituted for the chlorate.

Samples.	Lost Moisture per cent Air-dried.	Weight of Sample Air-dried=2·5 grms. in its original condition.
A.	5·77	2·356
B.	26·91	1·828
C.	8·48	2·288
D.	24·18	1·895
E.	0·94	2·477
F.	5·59	2·360
G.	2·08	2·448

The melt was treated with water and nitric acid: a residue always remained, except in the case of sample A, the solution of which was perfectly brilliant. It was considered unnecessary to separate the trace of silica from this sample. The silica in the other samples was separated as completely as possible by evaporation to dryness and heating the residue on the sand-bath at about 120° C. for two or three hours; in some cases for as long as five hours. The residue left on treating the mass with nitric acid and water was never pure silica: it was dried, removed from the filter, the latter burned, and the whole fused again with four times its weight of the oxidising mixture. This melt was treated in the same manner as the first, when the silica, as a rule, separated in a state of great purity. The solutions were united, and the whole accurately weighed.

Weights of Solutions in Grammes.

Samples.	Weights of Solutions each containing =2·5 grms. of manure in its original condition.	Equal Manure per cent.
A.	241·110	1·037
B.	220·671	1·133
C.	228·530	1·094
D.	209·800	1·192
E.	212·953	1·174
F.	195·771	1·277
G.	251·350	0·995

Four estimates were made with each sample, two by each method, one by each together. The quantity of solution taken was first roughly measured, and then carefully weighed.

Molybdic Method.

This was carried out essentially in accordance with the instructions given by Stunkel, Wetzke, and Paul Wagner (Chemical News, vol. xlvii., p. 66). They wash the precipitate with a neutral solution of ammonium nitrate, 100 grms. of the salt dissolved and made up to 1 litre. I used a solution very slightly aciduiated with nitric acid,

* As certain constituents in the ash are, as a rule, more or less decomposed during ignition it is impossible to get very concordant results in making two or more estimates with the same sample; I have therefore disregarded fractions.

and containing 150 grms. to the litre. They break the filter, and wash the precipitate into the beaker with dilute ammonia. I dissolved the precipitate *on* the filter by dropping dilute NH_3 (about 6 per cent) on it, and stirring it up with a jet of 2·5 per cent NH_3 delivered from a small wash-bottle.

Oxalic Acid Method.

I must refer the reader to my former article "On the Estimation of Phosphoric Acid" (Chemical News, vol. xlviii., p. 217) for details respecting the best manner of carrying out this process. I followed the same plan in these analyses. In some instances the precipitate was first collected on a pure paper filter, slightly washed, dissolved on the filter in 20 c.c. 10 per cent acetic acid, the solution made up to the usual volume, precipitated with NH_3 added very gradually, then added Mg Mix., and proceeded as usual.

Gooch's method of filtration was used at the end where re-precipitation was resorted to, and when this was done it will be indicated by the letter R. The same method of filtration was adopted in all the other experiments. The precipitates were filtered off after two or three hours, and were finally ignited over the blast.

Solution of Sample A. Factor 1·037.

	Weight of Solution taken in grms.	Equal Manure.	$Mg_2P_2O_7$ obtained.	Equal P_2O_5.	Equal per cent in Sample.	Averge.
			Molybdic.			
1	64·165	0·6654	0·1514	0·096835	14·55	14·60
2	63·417	0·6576	0·1506	0·096324	14·65	
			Oxalic.			
1	65·244	0·6766	0·1551	0·099202	14·66	14·63
2	45·340	0·4702	0·1073	0·06863	14·60	

Solution of Sample B. Factor 1·133.

			Molybdic.			
1	41·324	0·4682	0·0648	0·04145	8·85	8·85
2	41·443	0·4695	0·0650	0·04157	8·85	
			Oxalic.			
1	41·592	0·4712	0·0656	0·04196	8·90	8·89
2	41·822	0·4738	0·0658	0·04208	8·88	

Solution of Sample C. Factor 1·094.

			Molybdic.			
1	41·991	0·4594	0·1245	0·07963	17·33	17·31
2	41·256	0·4513	0·1220	0·07803	17·29	
			Oxalic.			
1	41·498	0·454	0·1247	0·07976	17·57	17·54
2	41·600	0·4551	0·1246	0·07969	17·51	

Solution of Sample D. Factor 1·192.

			Molybdic.			
1	36·783	0·4384	0·0447	0·02859	6·52	6·53
2	37·243	0·4439	0·0454	0·02904	6·54	
			Oxalic.			
R 1	36·810	0·4388	0·0482	0·03083	7·03	7·00
R 2	37·040	0·4415	0·0481	0·03076	6·97	

Solution of Sample E. Factor 1·174.

			Molybdic.			
1	36·964	0·4340	0·1589	0·10164	23·42	23·36
2	37·885	0·4448	0·1621	0·10368	23·31	
			Oxalic.			
1	37·195	0·4366	0·1620	0·10361	23·73	23·67
2	37·410	0·4392	0·1622	0·10374	23·62	

Solution of Sample F. Factor 1·277.

			Molybdic.			
1	37·824	0·4830	0·1146	0·0733	15·18	15·13
2	36·923	0·4715	0·1112	0·07112	15·08	
			Oxalic.			
1	37·232	0·4755	0·1150	0·07355	15·47	15·42
R 2	37·533	0·4793	0·1152	0·07368	15·37	

Solution of Sample G. Factor 0·995.

			Molybdic.			
1	42·100	0·4189	0·1970	0·1260	30·08	30·06
2	42·650	0·4244	0·1994	0·1275	30·05	
			Oxalic.			
1	41·925	0·4172	0·1976	0·1264	30·30	30·18
R 2	42·415	0·4220	0·1984	0·1269	30·07	

Another portion of solution, Sample D, containing about 0·5 grm. of the manure, was submitted to the oxalic method, and the precipitate of ammonio-magnesia phosphate collected on a paper filter, washed, dried, removed from the filter, and treated in a platinum dish in the usual way for the detection of silica. 0·002 grm. of the latter was obtained from this precipitate.

It is well known that the usual process—which was the one adopted in these experiments—for the elimination of silica fails to remove it completely. On dissolving the mass that has been heated for some time on the sand-bath in acid and water a trace of silica will as a rule go into solution. I was not aware, however, that this trace of silica would go down with the ammonio-magnesia phosphate. In fact direct experiment has shown that in the absence of alumina and ferric oxide this does not occur. Further experiments proved that even in the presence of ferric oxide, unless in notable quantity, a little silica may be present without vitiating the results to any important extent; but if alumina is present a minute quantity of silica in the solution has a very marked effect.

On the influence of a small quantity of silica in the presence of alumina and ferric oxide two series of experiments were made. A solution of silica was prepared by fusing 0·080 grm. with 2 grammes pure sodium carbonate, dissolving the melt in water, and making up to 200 c.c. 10 c.c. of this solution would therefore contain 0·004 grm. silica. Solution of ferric chloride was prepared. 10 c.c. =0·035 grm. ferric oxide, and solution of aluminum chloride 10 c.c. =0·010 grm. alumina. These solutions contained some excess of acid. A solution of microsmic salt was made of the same strength as that used in my experiments already published. The quantity used for each experiment would give about 0·2 grm. $Mg_2P_2O_7$. The solution was always accurately weighed and diluted as usual. The precipitates were ignited over the blast. The results were compared with test experiments, as in my former work. The quantity of phosphoric acid found for 100 parts taken is given as follows:—

First Series.

	Silica, 0·004 grm. Alumina, 0·020 grm. Ferric Oxide, 0·035 grm. Citric Acid, 2 grms.		Silica, 0·004 grm. Ferric Oxide, 0·035 grm. Citric Acid, 2 grms.		Tests corrected for the Blast.
1	102·30	4	99·85	7	100·01
2	102·45	5	100·40	8	100·11
3	103·10	6	100·55	9	100·06
Average	102·61		100·27		100·06

Second Series.

	Silica, 0·004 grm. Alumina, 0·020 grm. Citric Acid, 2 grms.		Silica, 0·004 grm. Ferric Oxide, 0·070 grm. Citric Acid, 2 grms.		Tests corrected for the Blast.
1	102·85	4	100·50	7	100·01
2	103·20	5	100·30	8	99·96
3	103·45	6	100·65	9	99·86
Average	103·16		100·48		99·94

On adding the ammonia in these experiments after introducing the citric acid, no turbidity was observed, nor was any apparent at this stage of the process in the analyses of the raw phosphates, even when the mixture was allowed to stand for some time before adding the Mg mix.

The following experiments were next made :—

No. I.

25 c.c. water.
1 grm. citric acid.
10 c.c. sol. silica=0·004 grm.
10 c.c. sol. aluminum chloride=0·010 grm.
10 c.c. 6 per cent NH_3.

The mixture remained quite brilliant, even after standing some time. Added 20 c.c. Mg mix. No. II. Immediate turbidity and after a little time a precipitate fell.

No. II.

Used all reagents as above except the sol. of silica, of which only 5 c.c.=0·002 grm. were introduced.

On adding the Mg mix. no turbidity at first, but it soon appeared; on standing a few minutes a precipitate fell.

Hence it appears aluminum silicate is soluble to a small extent in ammonium citrate, but *not so* in the presence of Mg mix.

It is apparent that the oxalic method, when applied to the estimation of phosphoric acid in fertilisers, will not as a rule give results strictly accurate, and the experiments detailed above seem clearly to show that this is due to its being practically impossible to remove all traces of silica from the solution, and that a minute quantity of this body will vitiate the results if alumina also is present. Disolving the precipitate in acid and re-precipitating does no good. In only one experiment out of four where this was done did the result agree with the molybdic, and this must therefore be considered accidental. I may state that a few milligrms. of citric acid were always added before re-precipitating. Samples A and B, it will be observed, gave concordant results with the two methods. In A alumina was absent; in B, if any was present, it could have only been a trace.

It has been held by many that it is unnecessary to separate the silica when the molybdic method is employed. Such experiments as I have made certainly prove that the $Mg_2P_2O_7$ will be free from silica if the quantity of the latter originally present in the solution was small. No silica was found in such of the precipitates from the molybdic method as I examined, and in one experiment with a solution of microsmic salt in which I introduced 0·008 grm. silica, and 0·040 grm. alumina,—being double the quantities used in the experiments that gave results so much above the truth by the oxalic method,—99·90 P_2O_5 was obtained instead of 100.

Experiments, however, with much larger quantities of silica, gave results not quite so satisfactory; therefore, in practice, I should remove it as completely as possible by the usual method before adding the molybdic reagent,

As regards the lime, in carrying out the oxalic method, a minute quantity remains in solution after adding the ammonium oxalate in excess, as the oxalic acid set free has a slight solvent action on the calcium oxalate. As this trace will go down on adding the ammonia and Mg mix. supposing no citric acid has been used, a second precipitation after dissolving in acetic acid is generally recommended. The necessity for this, however, may be obviated by adding 1·5 to 2 grms. citric acid at the proper stage, whether aluminum and iron are present or not, and counteracting the solvent action by the use of sufficient Mg mix., for—as I have proved by direct experiment—the formation of calcium oxalate is so greatly retarded by the presence of ammonium citrate, that if enough of the latter exists in the solution, and there is present only a little lime, it will be many hours before any trace of the latter is precipitated, even in presence of Mg mix.; therefore, if the ammonio-magnesia phosphate is filtered off after 3 or 4 hours, it will be found free from lime. On the other hand, I have found that with sufficient excess of Mg mix. the P_2O_5 will, in presence of ammonium citrate and oxalate, be precipitated as completely in two hours as in ten or more.

After nearly neutralising with NH_3, precipitating with oxalate in the heat, and filtering off the lime, I concentrate filtrate and washings to 30 c.c. to 40 c.c. A small further precipitate of calcium oxalate often forms, which is filtered off. The filtrate is made up with washings to the usual volume, citric acid added, then NH_3 and Mg mix.

Falmouth, Jamaica, B.W.I.
March 29, 1884.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
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TITANIUM.

THE earliest determinations of the atomic weight of titanium are due to Heinrich Rose.† In his first investigation he studied the conversion of titanium sulphide into titanic acid, and obtained erroneous results; later, in 1829, he published his analyses of the chloride.‡ This compound was purified by repeated rectifications over mercury and over potassium, and was weighed in bulbs of thin glass. These were broken under water in tightly stoppered flasks; the titanic acid was precipitated by ammonia, and the chlorine was estimated as silver chloride. The following results were obtained. In a fourth column I give the TiO_2 in percentages referred to $TiCl_4$ as 100; and in a fifth column the quantity of $TiCl_4$ proportional to 100 parts of AgCl :—

$TiCl_4$	TiO_2.	AgCl.	Per cent TiO_2.	AgCl Ratio.
0·885 grms.	0·379 grms.	2·661 grms.	42·825	33·258
2·6365 ,,	1·120 ,,	7·954 ,,	42·481	33·147
1·7157 ,,	0·732 ,,	5·172 ,,	42·665	33·173
3·0455 ,,	1·322 ,,	9·198 ,,	43·423	33·100
2·4403 ,,	1·056 ,,	7·372 ,,	43·273	33·102
		Mean	42·933 ± 0·121	33·156 ± 0·019

If we directly compare the AgCl with the TiO_2 we shall find 100 parts of the former proportional to the following quantities of the latter :—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Gilbert's Annalen*, 1823, 67, and 129.
‡ *Poggend. Annal.*, 15, 145. *Berz. Lehrbuch*, 3, 1210.

14·243
14·081
14·153
14·373
14·324

Mean 14·235 ± 0·036

From all these figures we can get three values for Ti, thus:—

From per cent TiO_2	Ti = 50·493 ±	0·410
,, AgCl : $TiCl_4$	,, 48·232	0·127
,, AgCl : TiO_2	,, 49·523	0·206
General mean ..	,, 48·710	0·105

These results will be discussed further along in connection with others.

Shortly after the appearance of Rose's paper, Mosander* published some figures giving the percentages of oxygen in titanium dioxide, from which a value for the atomic weight of titanium was deduced. Although no details are furnished as to experimental methods, and no actual weighings are given, I cite his percentages for whatever they may be worth:—

40·814
40·825
40·610
40·180
40·107
40·050
40·780
40·660
39·830

Mean 40·428

These figures give values for Ti ranging from 46·277 to 48·231; or, in mean, Ti = 47·045. They are not, however, sufficiently explicit to deserve any further consideration. It will be noticed that the highest value nearly coincides with Rose's lowest.

In 1847 Isidor Pierre made public a series of important determinations.† Titanium chloride, free from silicon and from iron, was prepared by the action of chlorine upon a mixture of carbon with pure artificial titanic acid. This chloride was weighed in sealed tubes, these were broken under water, and the resulting hydrochloric acid was titrated with a standard solution of silver after the method of Pelouze. I subjoin Pierre's weighings, and add, in a third column, the ratio of $TiCl_4$ to 100 parts of silver:—

$TiCl_4$.	Ag.	Ratio.
0·8215 grm.	1·84523 grm.	44·520
0·7740 ,,	1·73909 ,,	44·506
0·7775 ,,	1·74613 ,,	44·527
0·7160 ,,	1·61219 ,,	44·412
0·8085 ,,	1·82344 ,,	44·339
0·6325 ,,	1·42230 ,,	44·470
0·8155 ,,	1·83705 ,,	44·392
0·8165 ,,	1·83899 ,,	44·399
0·8065 ,,	1·81965 ,,	44·322
		Mean 44·432 ± 0·0173

It will be seen that the first three of these results agree well with each other and are much higher than the remaining six. The last four experiments were made purposely with tubes which had been previously opened, in order to determine the cause of the discrepancy. According to Pierre, the opening of a tube of titanium chloride admits a trace of atmospheric moisture. This causes a deposit of titanic acid near the mouth of the tube, and liberates hydrochloric acid. The latter gas being heavy, a part of it falls back into the tube, so that the remaining chloride is richer in chlorine and poorer in titanium than it should be. Hence, upon titration, too low figures for the atomic weight of titanium are obtained. Pierre accordingly rejects all but the first three of the above estimations:—

From all of Pierre's.. ..	Ti = 49·889 ±	0·096
,, the first three.. ..	,, 50·259	0·063

The memoir of Pierre upon the atomic weight of titanium was soon followed by a paper from Demoly,* who obtained much higher results. He also started out from titanic chloride, which was prepared from rutile. The latter substance was found to contain 1·8 per cent of silica; whence Demoly inferred that the $TiCl_4$ investigated by Rose and by Pierre might have been contaminated with $SiCl_4$, an impurity which would lower the value deduced for the atomic weight under consideration. Accordingly, in order to eliminate all such possible impurities, this process was resorted to: the chloride, after rectification over mercury and potassium, was acted upon by dry ammonia, whereupon the compound $TiCl_4.4NH_3$ was deposited as a white powder. This was ignited in dry ammonia gas, and the residue, by means of chlorine, was re-converted into titanic chloride, which was again repeatedly rectified over mercury, potatsium, and potassium amalgam. The product boiled steadily at 135°. This chloride, after weighing in a glass bulb, was decomposed by water, the titanic acid was precipitated by ammonia, and the chlorine was estimated in the filtrate as silver chloride. Three analyses were performed, yielding the following results. I give the actual weighings:—

Grms.	Grms.	Grms.
1·470 $TiCl_4$ gave	4·241 AgCl and	0·565 TiO_2.
2·330 ,,	6·752 ,,	0·801 ,,
2·880 ,,	8·330 ,,	1·088 ,,

The "0·801" in the last column is certainly a misprint for 0·901. Assuming this correction, the results may be given in three ratios, thus:—

Per cent TiO_2 from $TiCl_4$.	$TiCl_4$: 100 AgCl.	TiO_2 : 100 AgCl.
38·435	34·662	13·322
38·669	34·508	13·344
37·778	34·574	13·061
Mean 38·294 ± 0·180	34·581 ± 0·030	13·242 ± 0·061

These three ratios give three widely divergent values for the atomic weight of titanium:—

From per cent TiO_2.. ..	Ti = 36·063 ±	0·519
,, AgCl : TiO_2	,, 43·841	0·350
,, AgCl : $TiCl_4$	,, 56·386	0·181
General mean ..	,, 52·191	0·153

The value assumed by Demoly is 56, who employs but one ratio and ignores practically the others.

Upon comparing Demoly's figures with those obtained by Rose, certain points of similarity are plainly to be noted. Both sets of results were reached by essentially the same method; and in both the discordance between the percentages of titanic acid and of silver chloride is glaring. This discordance can rationally be accounted for by assuming that the titanic chloride was in neither case absolutely what it purported to be; that, in brief, it must have contained impurities; such for example as hydrochloric acid, as shown in the experiments of Pierre, or possibly traces of oxychlorides. Considerations of this kind also throw doubt upon the results attained by Pierre, for he neglected the direct estimation of the titanic acid altogether, thus leaving us without means for correctly judging as to the character of his material. In fact, not one of the determinations of the atomic weight of titanium can be regarded as trustworthy. All depend upon the chloride, and the volatile chlorides of metals are as a class especially liable to contaminations of a kind most difficult to recognise. Possibly a series of good

* *Berz. Jahresbericht.* 10, 108. 1831.
† *Ann. d. Chim. et de Phys.*, (3), 20, 257.

* *Ann. Chem. Pharm.*, 72, 214 *Berz. Jahresb.* 30, 58.

determinations might be based upon analyses of some of the titano-fluorides. I subjoin a combination of the foregoing mean values, feeling that such a general average is a little better than any one set of determinations taken singly:—

From Rose's analyses ..	Ti = 48·710	± 0·105
,, Pierre's ,, ..	,, 49·889	0·096
,, Demoly's ,, ..	,, 52·191	0·153
General mean ..	,, 49·846	0·064

Or, O = 16, Ti = 49·961.

This mean agrees with the average of all of Pierre's experiments.

The following additional note has been communicated by the author:—

All the foregoing work upon titanium has been completely supplanted by the recent researches of Thorpe. As his paper has quite lately appeared in the CHEMICAL NEWS (vol. xlviii., p. 251) its details need not be reiterated here; but a statement of the results obtained by recalculating his figures may fairly be given.

First, in eight experiments, $TiCl_4$ was decomposed by water and titrated against silver solution. In mean, 100 parts of silver balance 43·999, ± 0·0032, of $TiCl_4$. Hence Ti = 48·024 ± 0·065.

Second, in five experiments $TiCl_4$ was similarly decomposed, and the chlorine was weighed as AgCl. In mean, 100 parts of AgCl balance 33·118 ± 0·0019 of $TiCl_4$. Hence Ti = 48·015 ± 0·068.

Third, in six experiments $TiCl_4$ was decomposed by water, the solution was evaporated to dryness, and the residual TiO_2 was weighed. In mean, $TiCl_4$ yields 42·171 ± 0·0022 per cent of TiO. Hence Ti = 47·963 ± 0·043.

The general mean of these three values is Ti = 47·980 ± 0·032. If O = 16 this becomes 48·100. The complete concordance of the three results establishes the purity of the material studied.

A FLASHING TEST FOR GUNPOWDER.

By C. E. MUNROE, S.B. (Harv.).

AMONG the methods in use for the determination of the condition and quality of gunpowder is the "flashing test." According to the "Ordnance Instructions U.S. Navy," p. 345, "about eight drams of powder are poured on a glass plate so as to form a conical heap, and 'flashed' by applying a hot iron; no residuum should be left and only a few smoke marks should be seen on the plate." Capt. Smith, R.A., in his "Handbook of the Manufacture and Proof of Gunpowder," p. 83, proceeds in the same way, but he places the powder in a thimble-shaped, copper cylinder, "which is then inverted on the flashing plate. This provides for the particles being arranged in pretty nearly the same way each time, which is an all-important point in flashing. The decomposition of the powder will be more thorough if it be thrown together in a conical heap than if it be spread out in a thin layer on the plate; hence, for comparison of different powders, they should be placed on the plates as nearly as possible under the same conditions. If the powder has been thoroughly and effectually incorporated the small charge placed on the plate will 'flash' or puff off when touched with a hot iron, leaving only smoke marks on the plate. A badly incorporated powder will, on the other hand, leave specks of undecomposed saltpetre and sulphur, and will therefore give a dirty residue. But the 'flashing' test, though apparently most simple, is one which, like the examination by eye and hand, requires experience to enable the observer to form an accurate judgment. Though a very badly incorporated powder could be detected at once, it is by no means easy to judge between two powders, both tolerably good, as to which has undergone the most thorough incorporation. Flashing should therefore be constantly practised with all classes of powders, and it is useful to keep some samples of bad powders to flash occasionally for comparison. Powder which has once been subjected to and injured by damp will be found to flash very badly, no matter how carefully its incorporation may have been performed. This arises from a partial solution of the saltpetre having taken place, causing a consequent disturbance of the incorporation."

Com. J. D. Marvin, U.S.N., in his "Objects and Resources of the Naval Experimental Battery, p. 18, repeats the above directions and suggests weighing the plate on which the flash has been made, but, as he provides no means to prevent the absorption of moisture and oxygen, and the escape of the hydrogen and ammonium sulphides, the method is of no value.

In the *Comptes Rendus*, 78, 1138, 1874, Col. Chabrier proposes, what he terms a *pyrographic* method for the examination of gunpowder, and a detailed account is given in the *Revue d'Artillerie*, iv., 396, 1874, of its application by the Comité de L'Artillerie in determining the relative value of wheel mills, stamp mills, and *moulins à tonneaux* in effecting incorporation, and of the length of time necessary in each case to produce the desired result.

This method consists in flashing the powder on sheets of paper, coloured blue with iodide starch. Sheets of uniform tint, 0·30 metre long by 0·15 metre wide, are dampened and placed on a plate of glass of the same size. A half gram of powder is then trailed on the paper, following the longer axis. It is flashed by a red hot iron wire and it is found that the centre of the blue paper is bleached, while black spots and streaks appear on the white ground and white spots on the blue ground. The size and shape of the bleached space and the number and arrangement of the spots and streaks are determined by the character and amount of the powder used. Col. Chabrier does not give the *rationale* of his process, but it is to be inferred from the fact that he styles these results *pyrographic* images that he believes the breaching to be due to the heat evolved by the combustion. The well-known experiment of the bleaching of starch paste, coloured blue with iodine, by heating in a test-tube, is an example of the same kind.

This process is an advance upon the older one, but in applying it some years ago I found it difficult to prepare papers of the same degree of blueness, and that the evanescent character of the colour made it difficult to preserve the test papers intact for any considerable length of time; so, as before, we must either practise the method continually or else flash powders, which we have kept as standards for comparison, with each set of tests we make, in order to arrive at any good results. Or, finally, we may photograph the test papers, but this involves considerable labour and the loss of the colour.

Since the flashing test is the simplest, readiest, and in the hands of an expert the best, test for the incorporation of powder, and since it also fairly indicates the amount of deterioration which a powder has undergone during transportation and storage, it has seemed to me desirable to seek some method by which the record could be made permanent. Such a reeord could then be filed at the factory with the other data concerning a given powder, or, in the case of the Government, they could be inclosed with the quarterly returns of the inspecting officers at distant stations, to be examined by some expert in the Bureau. Specimens of the tests of standard powders could also be furnished inspecting officers, to guide them in the interpretation of the results of their tests, and finally, a sample of the required test might be attached to the specifications for a gunpowder to be purchased.

After some search I believe I have secured such a permanent record, by employing a paper coloured with Turnbull's Blue, upon which to make my flash. This paper is the same as that used in the "Blue Print Process" of photography, and is easily procured in commerce. The

use of the paper was suggested by the following facts. When gunpowder burns the reaction which takes place may, according to Debus, *Proc. U. S. Naval Institute*, 9, 76, 1883, be represented by the reaction—

$$16KNO_3+13C+5S=3K_2CO_3+5K_2SO_4+9CO_2+CO\times\times 8N_2.$$

Sincs, however, in ordinary gun powders there is more carbon and sulphur than is required by the above equation, secondary, endothermic reactions take place, which may be combined and represented as follows :—

$$3K_2SO_4+2K_2CO_3+7C+7S=5K_2S_2+9CO_2.$$

Further, on exposure to the air, the polysulphides formed are oxidised to thiosulphates. I have observed that, in my experiments, the characteristic smell of the latter was most noticeable when the powder was badly incorporated.

It is well known that solutions of the alkalies and the alkaline carbonates decompose Turnbull's Blue and thereby destroy its colour. Advantage has been taken of this reaction to increase the distinctness of "Blue Prints," or to make such additions to them or alterations in them as desired. With this I exhibit a specimen of the blue paper, upon which one of the above reactions is written by the aid of a solution of potassium carbonate. The alkaline sulphides and thiosulphates also act upon the blue paper, but with less intensity and with the partial production of a yellow colour. By flashing gunpowder then, upon such paper, yellow and white spots will be formed through the action of the substances formed by the reaction.

The test is made as follows:—Pieces of the paper, from 15 to 20 centimetres square, are dampened and placed on a sheet of glass or copper. A truncated leaden cone 3 centimetres in capacity is closed with the finger at the smaller end, filled evenly with powder, and inverted on the paper. The result is a conical heap. The heap is immediately fired, either by a hot iron or copper wire, or, as in my experiments, by a fine platinum wire, heated to incandescence by an electric current. The paper is exposed to the action of the residue for thirty seconds and then immediately placed under the spigot and washed with running water. When pulverised gunpowder cake is used it will be found that the space described by the base of the cone has been blackened and partially bleached by the dampened layers of powder in contact with it: that about this space are black smutches and streaks, and that the whole surface of the paper is marked by white and yellow dots. Where the powder is badly incorporated the spots are coarse, and irregular in shape and distribution; where the incorporation is complete, the spots are fine and quite uniformly distributed over the surface, so that the paper appears but of a paler blue, with occasional spots and few streaks.

With this I forward specimens of tests made with powdered "milk cake." All of the specimens belong to the same "charge," but the first was drawn after the mill had been running four hours; the second, at the end of eight hours; the third, after twelve hours; and the fourth, after sixteen hours. The latter is known as the "finished composition." This length of running is rather unusual, but the charge used at the mills is greater than common. The tests exhibited were made October 19, 1883. I have yet others made April 26, 1883, which are today apparently as fresh and distinct as when made. It is believed that the papers show what is described above. That importance is given, in interpreting the results, to uniformity of the bleaching and in the arrangement of the spots, depends upon the fact that gunpowder is a mechanical mixture, and, therefore, that the regularity of the combustion and the uniformity of the accompanying reactions must depend upon the fineness of the ingredients and the intimacy and uniformity of the mixture. If the ingredients are coarse and the mixture imperfect, the combustion will go on slowly and irregularly, and the resulting globules of residue will be of considerable size and be deposited near the centre of action. If the incorporation is complete, the reaction will take place nearly simultaneously throughout the whole mass, and the globules will be, as a rule, quite small and projected to some distance. This interpretation is for mealed powders having the same formula. I have not yet been able, personally, to extend my experiments to granulated powders or powders of varying proportions and ingredients, but I believe that this test will form a useful method for the study of these powders.

In order that the indications may be interpreted aright, it is necessary that the conditions under which the experiments are made shall be as nearly uniform as possible, and the first of these is that the colour of the test paper should be in all cases as nearly as possible of the same depth. The paper may be purchased in an emergency, but it varies among manufacturers owing to the many different formulæ according to which it is made. Among these I have selected that issued by the Penn. R. R. Co. for use among its operatives.

"Take 10 ozs. (283·5 c.c.) of clean water and put in an opaque bottle, add 1¼ oz. (35·44 grms.), of red prussiate of potash; allow this to dissolve. In a second vessel containing 6 ozs. (170·1 c.c.) of water put 2½ ozs. (70·88 grms.), of ammonio-citrate of iron, allowing this also to dissolve. Add the second liquid to the first and shake thoroughly. Keep closely stoppered and not exposed to light."

"In a room from which daylight is excluded, but where lamp or gas light may be used, the paper to be printed on is laid on a table, and the fluid applied with a *clean* sponge. Care should be taken to apply the fluid as evenly as possible, and every part of one side should be gone over. For that reason it would be well to sponge the paper, first in one direction, and afterwards crosswise to the first. When a sheet is sensitised it is put away in a drawer to dry, but never place one sheet on the top of another before they are dry; afterward it makes no difference. Sensitised paper may be kept in a drawer for a week or more, without injuring its sensitive quality."

"In using the fluid, care should be taken to pour out no more than is needed for the time, as it would be apt to spoil the fluid in the bottle if any fluid which had been used was poured back again. For the same reason the saucer into which the fluid is poured, and the sponge with which it is applied, should be washed out immediately after using and also before using."

For the purposes of this test for gunpowder the dry sheets are now exposed to strong sunlight for four or five hours. When about to use, immerse in running water for five minutes, lay on the plate of glass and remove the excess of moisture by aid of filter-paper or a blotter. The paper must be thoroughly moistened, but without "standing" moisture.

Since writing the above I have received from Lieutenant Commander W. M. Folger, U.S.N., commanding the Naval Experimental Battery, the following statement concerning the testing of a granulated powder by this method.

"In firing a sample of experimental powder lately, I had reason to believe, from its performance in the gun (calibre 6"), that the powder was badly incorporated. Tested in the manner you suggested with Turnbull's paper and following all your directions, indications were furnished which (when compared with results obtained with a normal sample of approved powder) verified most definitely the value of the method you suggest."—*Journal of the American Chemical Society.*

Transmission of Sound by Gases.—M. Neyreneuf.—The author finds no difference between air, nitrogen binoxide, and hydrogen bicarbide, the densities of which are almost equal. The law indicated (*Comptes Rendus*, vol. xcvi.) for carbonic acid applies with sufficient accuracy to nitrogen protoxide and ammonia.—*Comptes Rendus.*

A SIMPLE METHOD OF EXTRACTING CÆSIUM AND RUBIDIUM COMPOUNDS FROM HEBRON LEPIDOLITE.

By F. C. ROBINSON and C. C. HUTCHINS.

Lepidolite from Hebron, Maine, has been shown to contain cæsium and rubidium in considerable quantities. The following is a simple and effective method of obtaining the compounds of these metals:—

The mineral is pounded in an iron mortar until it feels soft to the touch; mixed in the mortar with an equal weight of fluor-spar, and the two ground together for a few minutes to secure intimate mixture. The mixture is transferred to a leaden dish, made into a thin paste with common strong sulphuric acid, and heated on a sand-bath for two or three hours, or until the mass is hard and dry.

When cold the mass is broken up, placed in a porcelain dish, and boiled out three times with water, the water in each case being poured, while hot, through a filter.

The filtrate contains cæsium, rubidium, and potassium as alums. These alums are about equally soluble in hot water, but at 17° the potash alum is nearly six times more soluble than the rubidium alum, and twenty-two times more soluble than the cæsium compound (Redtenbacher). Hence it is easy, by means of these differences, to separate the rubidium and cæsium compounds from the last traces of potassium, and from each other.

1000 grains of lepidolite, treated in the above manner, yield about 30 grains of cæsium and rubidium alums.

The process seems to commend itself on account of (1) its cheapness, the only reagents used being common fluor-spar and sulphuric acid; (2) the short time required —but a single day; (3) avoiding the use of platinic chloride, and fusion of the mineral.—*American Chemical Journal*, March, 1884.

AMMONIUM FLUORIDE AS A BLOWPIPE REAGENT.

By Prof. N. W. LORD, E.M., Ohio State University, Columbus, Ohio.

The use of bisulphate of potassa and fluor spar as a reagent for developing the flame colouration of boron is well known; but the alkali present prevents the application of the method for liberating some other bodies in the same way. I find fluoride of ammonium, on the contrary, has all the value of fluor-spar as a source of fluorine, admits of much easier application, and is a most useful reagent for detecting the alkalies, boron, and other similar bodies in their mineral combinations. The method of using the reagent is simple. For testing felspar, or similar silicates, a little of the powdered mineral is mixed with this reagent, then placed on a piece of platinum, and moistened with sulphuric acid; the mixture allowed to stand a few moments, or else gently warmed, taken upon a loop of platinum wire, and tested either in the blowpipe flame or in a Bunsen burner, being dried a little on the wire first. The alkali flame is nearly as well shown as with the pure salts. As the fluoride of ammonium is permanent, is easily obtained free from alkalies and boron, and can be kept indefinitely in a small wooden box, it is always easy to use.

As a test for boron the reaction is of surprising delicacy. The fact that the fluoride of boron is volatile at a temperature far below that required for alkalies permits thus its detection in borax or any alkaline compound. To a drop of sulphuric acid, placed on a platinum crucible cover, a few grains of the fluoride should be added, and then the mineral (powdered) to form a paste. This is taken as before described, as a platinum loop. It should be heated gently until it stops "sputtering" from escape of free acid and water (but on no account heated to redness), then brought not *in*, but *near*, the lower part of the flame of a Bunsen burner or a good blowpipe flame. A bright green colouration is at once given, untinged by soda-yellow. The colouration is, of course, evanescent, and disappears before the assay is red-hot. A little practice is needed to find the right part of the flame, to get the right heat, and at the same time to draw the volatile boron compound into the heated zone.

This reaction showed boron very strongly in all the specimens of tourmaline tested. With a hand spectroscope the application of this method gives instant proof of the existence of boron, potassa, soda, and lithia, even in very small traces in rocks.

Borax treated in this way gave a bright green flame, almost like copper.—*Engineering and Mining Journal.*

NOTICES OF BOOKS.

A Treatise on Chemistry By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in the Victoria University, Owens College, Manchester. Vol. III. The Chemistry of the Hydrocarbons and their Derivatives, or Organic Chemistry. Part II. London: Macmillan and Co.

This valuable work advances slowly to completion. The present volume comprises a general account of the olefines, their substitution products, the methylene, ethylene, ethidene, glycolyl compounds, proceeding thence on to the olefines containing more than eight atoms of carbon. Next follow the uric acid derivatives, including caffeine and theo-bromine, which, to the horror of non-chemists, are now found to stand in close relation to excrementitious principles such as uric acid. The writers even suggest that it may be possible to prepare theo-bromine and caffeine from guano. Fortunately, two circumstances oppose themselves to this fresh inroad upon the domain of agriculture: the world's stock of guano is rapidly diminishing, and caffeine and theo-bromine, though they occur in several important articles of food, do not of themselves constitute such articles. These two bodies, though capable of combining with acids and having a feeble basic character, are now no longer classed among the alkaloids. Caffeine, the methyl derivative of theo-bromine, has the distinguishing privilege of being poisonous, though the quantity likely to prove fatal to a man is not likely to be taken in the form of tea or coffee.

Among the uric acid group we find, further, murexide (ammonium purpurate) now dethroned from its position as a dye-ware. It is said that about twenty-five years ago murexide was used in dye- and print-works in such quantity that the factory of Mr. Rumney, in Manchester, turned out 12 cwts. weekly, consuming for this purpose 12 tons of guano. This manufacture, we are told, was but short-lived, as it was soon superseded by the coal-tar colours, which are equally beautiful and less costly. It must not be forgotten that the gradual decline of Peruvian guano in quality coupled with a rising market-price had an unfavourable influence on this manufacture.

Upon the uric acid derivatives follow the compounds of triad radicals, among which stands foremost glycerin, or, as the authors prefer to name it, glycerol. We have a full account of the preparation of this important compound both from fats and oils and from the waste lyes of soap-works. Among the applications of glycerin we find no mention of its uses in dyeing and the collateral arts.

Amongst its derivatives a prominent place is naturally given to propenyl tri-nitrate, the evil spirit of the age, better known as nitroglycerin. It may well be questioned whether the mischief already wrought by this compound

does not outweigh all the benefits which may arise from its legitimate uses. The fats and oils, those namely which along with trioleine contain glycerides of the fatty acids, are noticed somewhat briefly.

Among the lecithins we find mention of the disputed body protagon, said by some to consist of a mixture of lecithin and cerebrin. We find here no notice of its alleged preparation from vegetable sources.

Passing over the allyl, acryl, and crotyl compounds, we come to citric acid. Concerning the occurrence of this acid we find an apparent slip of the pen. It is remarked that citric acid "accompanied with little or no malic acid is found in the whortleberry," whilst in the next sentence we read that "together with about an equal quantity of malic acid it is found in the bilberry." Now we have always understood that "whortleberry" and "bilberry" are synonyms for one and the same fruit, the former name being used in the West and the latter in the North of England.

The carbohydrates are discussed at great length. We find, however, no reference to the opinion now entertained in some quarters that cane-sugar (saccharose) and beet-sugar (betose), though agreeing in their centesimal composition, are not truly identical, but must be regarded as isomers.

The manufacture and the analysis of sugar are described at length with the accompaniment of numerous and well executed illustrations.

The uses of starch-sugar, chiefly fraudulent, are duly noticed.

Under gum arabic we find the statement quoted from the *Annales de Chemie et Pharmacie* that "silk worms and other insects contain gum of a similar character." It might have been well to state in what part of the body of such insects this gum is secreted and stored up, since possibly some persons may mistake the silk, in its original fluid state, for gum. We need scarcely say that it differs by containing nitrogen, which the gums do not.

Under cellulose we find due mention of its most prominent derivative, gun-cotton or cellulose hexnitrate, formerly supposed to be a trinitrate. It is remarkable that this substance, though it has occasioned no little mischief in other ways, has not been employed by assassins and other criminals to the same extent as dynamite. With reference to the great Stowmarket explosion of August, 1871, we find the following remark:—"On investigation it was ascertained that some of the stock of gun-cotton contained acid, *owing either to insufficient washing*, or to the felonious addition of acid to the properly washed gun-cotton." The addition of the words which we have italicised is, in our opinion, to be regretted. If the gun-cotton had been insufficiently washed it is simply inconceivable that there could have been found in each of some twenty boxes examined one disk of acidified cotton, whilst the rest was perfectly sound and good. In accordance with these facts the jury returned no alternative verdict, but positively declared that acid had been maliciously added to a part of the finished stock.

In treating of the technical uses of cellulose, most of which are of course of a mechanical character, the authors give a series of well executed illustrations showing the microscopic characters of the fibres of cotton, flax, and hemp. Mention is made of the discoveries of Luca and Virchow that cellulose occurs in the skin of silkworms, of snakes, in the human brain, and in the diseased spleen.

The volume before us fully maintains the reputation earned by the former portions of the work for accuracy and thoroughness. There is not in the English language any systematic treatise on chemistry which can be compared with it in these essential respects. The student who wishes for more detailed information on any particular subject finds at the foot of almost every page references to the original memoirs from which the text has been compiled. The index is full, and as far as we have been able to test it, accurate.

The Scientific Papers of James Prescot Joule, D.C.L., LLD., F.R.S., &c. Published by the Physical Society of London. London: Taylor and Francis.

This volume contains those papers which have appeared in the author's own name, arranged, as nearly as possible, in chronological order. In it we find a rare wealth of important research on the most varied physical questions. Electricity, magnetism, heat, sound, as well as the physical side of chemistry, have chiefly occupied the author's attention, and it is not too much to say that whatever he touched he has adorned.

In view of an important enquiry now in progress we will first call attention to one of Mr. Joule's less known memoirs, treating on the "Utilisation of the Sewage of London and other large Towns." We cannot without gratification notice that his views coincide in the main with those which have been advocated in the Chemical News. He protested against the "main drainage scheme," which is now found wanting, as "a stride in the wrong direction, which if persevered in and copied by other towns must be fraught with disastrous consequences to the national prosperity." He condenses the meaning of a notorious passage in the report of the Government Referees as follows:—"We will take care to dilute and remove the sewage, and when, as we have shown, private enterprise will be unremunerative we will invite it." He asserts, in complete accordance with the conclusion recently come to by the Commission of enquiry, that "the portion of sewage which arrives at the outfalls will not be entirely prevented from returning to the metropolis." He bases this conclusion that the sea-water penetrates occasionally as far as London Bridge. He further quotes the admission of Messrs. Hawksley, Bidder, and Bazalgette, that it is "extremely uudesirable in a sanitary point of view to cause sewage-water to be intermixed with sea-water," and their additional conclusions "that the cost and difficulties attending the application of liquid sewage in large quantities are absolutely prohibitory of its use," and further, "that liquid sewage cannot in general be used with advantage in this climate, except in particular states of the weather and in certain stages of the growth of the crops to which it is applied." Mr. Joule proposes a return to a modified cesspool system, the excreta being received in air and water-tight tanks, serving each, say, 50 houses, and emptied every night with proper appliances, chemical and mechanical, to prevent nuisance.

Perhaps the most celebrated among the 98 memoirs contained in the volume before us is that on the mechanical equivalent of heat, read before the Royal Society in 1849. The author traces the history of the now accepted theory of the non-materiality of heat from the conjecture of Locke and the experiments of Count Rumford to the more precise determinations of the present day. He describes at length the apparatus and the method of experimentation by which he proved that heat was liberated in measurable quantities by the friction of water, of mercury, and of cast-iron. These experiments led him to the now well-known propositions:—"That the quantity of heat produced by the friction of bodies, solid or liquid, is always proportional to the quantity of force expended," and "that the quantity of heat capable of increasing the temperature of a pound of water (weighed in vacuo and taken at between 55° and 60° by 1° F., requires for its evolution the expenditure of a mechanical force represented by the fall of 772 lbs. through the space of 1 foot."

In a memoir on some amalgams conducted with especial attention to their physical properties, Mr. Joule mentions the fact that the amalgams of lead and of tin are decomposed by pressure. This reminds us of the recent experiments of Prof. Spring on pressure as a chemical agent. Mr. Joule made an unsuccessful attempt to form an amalgam of hydrogen and mercury at 4° F. No trace of hydrogen was taken up, but the author thinks that with the aid of intense cold and high pressure this interesting experiment might be successful.

A very noteworty paper is that on the fusion of metals

by voltaic electricity. Mr. Joule witnessed and afterwards repeated certain experiments in this direction. With a battery of six Daniells he succeeded in fusing several steel wires into one, uniting steel wire with brass, platinum with iron, &c. The wires were placed in glass tubes and surrounded with charcoal to prevent oxidation. The author suggests that this process might be of some utility in place of soldering whenever it is required to join together sparingly fusible metals without the interposition of another which melts at a lower temperature, and which, moreover, is in many cases readily acted on by a variety of chemical agents.

Mr. Joule shows, indeed, that so long as the battery is used as the source of the voltaic current this process cannot be profitably used on the large scale, since 5000 grains of zinc would be the minimum consumption in a Daniell element to effect the fusion of 1 lb. of iron, whilst 1-5th the weight of coal would have the same effect. But he does not forget that the current can be much more economically obtained by a magneto-electrical machine. Thus metallurgical operations may be profitably conducted in mountain regions where coal is wanting if water-power is available.

In 1871 Mr. Joule was led to examine into the "Alleged Action of Cold in rendering Iron and Steel Brittle." From a series of carefully conducted experiments he infers that frost does not make iron (cast or wrought) or steel brittle, and that the accidents said to spring from this cause are in reality due to the omission to submit wheels, axles, &c., to practical and sufficient tests before using them. The greater frequency of such accidents in frosty weather he attributes to the greater rigidity of the ground.

In an essay on "Shooting Stars" the author mentions the three hypotheses put forward by Sir J. Lubbock for their explanation. His own theory, like that of Chladni, is that meteorites are miniature planetary bodies, their ignition being due to their violent collision with our atmosphere, thus affording a "remarkable illustration of the doctrine of the equivalency of heat to mechanical power, or *vis viva*." The effect of the heat thus liberated is that, in general, the meteorites entering our atmosphere are melted and frequently dissipated. One difficulty remains: it is asserted that some meteorites, examined immediately on their fall—a rare case—have been found intensely cold, as if they brought with them the low temperature of the depths of space.

In a notice on the "Intensity of Light during the Solar Eclipse of April, 1858," the author found that the light was reduced to about 1-150th of its normal quantity. He infers, in accordance with Mr. Dancer, that the circumference of the sun's disk gives out a very feeble radiation, as measured by a sensitive plate, in comparison with the central part. Mr. Dancer considers it indeed impossible in photographing the sun to obtain in the same image a satisfactory impression both of the central region and of the circumference.

It will be remembered that the greater part of Mr. Joule's chief researches were made a considerable number of years ago. There is, consequently, in this volume little which to the physicist will have the value of novelty. Nevertheless the memoirs here published, those especially on the mechanical equivalent of heat, have more than a mere historical value. Now attempts are being made to raise "caloric" from its grave, and reinstate the material theory of heat, the original memoirs of Mr. Joule will be important documents for reference.

The Neutral Didymium Molybdate and the Valence of Didymium.—Alph. Cossa.—The author has obtained the neutral didymium molybdate in crystals by simply fusing the amorphous molybdate at a very high temperature. These crystals are isomorphous with lead molybdate. Hence he considers that didymium oxide should be represented by the formula DiO.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 16, April 21, 1884.

On the Scale of Temperatures and on Molecular Weights.—M. Berthelot.—The author asks:—"In the midst of these incessant and progressive changes of the gases reputed as simple, under the influence of high temperatures what becomes of our conventions and our atomic hypotheses on the number of molecules,—hypotheses constructed solely according to data observed in the neighbourhood of the ordinary temperature? Will the constitution of the ultimate particles of our elementary bodies be henceforth arbitrarily simplified? The fundamental study of specific heats which have been lately invoked in support of these hypotheses tends to establish that heat, which dissociates compound molecules into their elements, acts in a similar manner to disaggregate the groups, doubtless very complex, which form the so-called elementary matters."

Optical Identity of the Crystals of the Herderite of Ehrenfriedersdorff and that of the State of Maine.—M. des Cloizeaux.—The nature of this paper appears sufficiently from its title.

Separation of Phosphoric Acid in Arable Soils.—M. de Gasparin.—The author admits the criticisms of M. Lechartier (*Comptes Rendus*, March 31, 1884), and shows by a letter addressed to M. Peligot that he had himself detected the error in his analytical method pointed out by M. Lechartier.

Boiling-Points of Oxygen, Air, Nitrogen, and Carbon Monoxide under the Atmospheric Pressure.—S. Wroblewski.—The boiling-point of perfectly pure oxygen is $-184°$, that of air $-192.2°$, that of nitrogen $-194.3°$. It is remarked that the elements of air do not separate when liquefied. The boiling-point of carbon monoxide containing 6 per cent of carbon dioxide is $-186°$. If we take the boiling-point of carbon dioxide at $-80°$, that of pure carbon monoxide will be $-193°$, or nearly the same as that of nitrogen. When these gases are evaporated in a vacuum the temperature descends a few degrees below $-200°$. Atmospheric air will be the refrigerator of the future.

On a Metallic Radicle.—P. Schützenberger.—It is generally supposed that an alloy if submitted to the action of oxidising or chlorinising reagents yields compounds corresponding to the constituent metals. The author has met with an alloy of platinum and tin which behaves in a different manner. If this alloy is treated with hydrochloric acid in a flask filled with hydrogen or carbon dioxide a part of the tin is dissolved out as stannous chloride and there remains a soft body having the touch of graphite and composed of platinum, tin, chlorine, oxygen, and hydrogen. The chlorine is removed by prolonged washing, and there remains a body which when dried in a vacuum over sulphuric acid consists of $Pt_2Sn_3\Theta_4H_2$.

Determination of the Vapour Densities of Glucinium Chloride.—MM. L. F. Nilson and Otto Pettersson.—If this compound is regarded as GlCl the specific gravity is 1·385, if as $GlCl_2$ 2·770, if as $GlCl_3$ it becomes 4·155, and if as Gl_2Cl_6 it will be 8·310. If Avogadro's law is applied to the values found the molecule of glucinium chloride is represented by $GlCl_2$ at temperatures between 686° and 812°. As regards the atomic weight of glucinium the laws of Dulong and of Avogadro lead to contradictory results—the first known case for a metallic element. According to Avogadro's law Gl = 9·1, a value which agrees well with the periodic system of the elements.

On the Curves of the Solubility of Salts.—A. Etard.—The solubility of salts is generally represented by curves showing the quantity of the salt which can be dissolved in 100 parts of water. For these the author substitutes others, showing the quantity of anhydrous salt contained in 100 parts by weight of the solution. In this method of representing solubilities all the results are comprised between 0° and 100° the curves are more susceptible of comparison and of chemical interpretation, as they give, for each temperature, the centesimal composition of the liquid, *i.e*, an analysis comparable, in all points, to ordinary chemical analyses, and which admits of a rapid calculation of the relation between the salt and the water of solution. Whatever may be the nature of the salt employed its solubility within a certain interval of temperature is always represented by a right line forming a greater or smaller angle with the axis of the temperatures. This right line represents the normal phenomenon of solubility for a certain state of equilibrium between the water and the dissolved salt considered in the anhydrous or hydrated state. But as the temperature continues to rise there arrives a point where the original equilibrium can no longer subsist. A new state becomes established and during the larger or smaller interval of temperature within which this change is effected, the right line is deflected. But as soon as a new equilibrium is established the solubility again becomes proportional to the temperature, and we again find a right line.

The Bark of Zanthoxylum Caribæum and its Chemical Composition.—MM. Heckel and Schlagdenhauffen.—In this bark the authors have discovered a compound, $C_{12}H_{24}O$, and a poisonous nitrogenous base the composition of which they have not determined. Nitric acid gives it a bright red colour. The nitric solution, evaporated to dryness on the water-bath, and treated with a drop of stannous chloride, does not turn violet, like brucine.

Sterilisation of Liquids by means of Papin's Digester.—L. Heydenreich.—It is necessary that the digester should be exhausted of air previous to heating.

Cosmos les Mondes.
No. 11, March 15, 1884.

Improvements in the Manufacture of Sulphuric Acid.—To obtain pure monohydrated acid M. G. Lunde (Lunge ?), of Zurich, utilises the property of sulphuric acid, at 98 per cent, of giving, when cooled below 0°, crystals of the monohydrated acid. He finds that the commercial acids of 96 and 97 per cent, when refrigerated, present the phenomenon of superfusion, and in this condition is readily induced to crystallise by the addition of a crystal of the monohydrated acid. He commences by preparing a small quantity of crystalline monohydrated acid, by refrigerating acid at 98 per cent down to − 10°. This small quantity of crystals serves then to determine crystallisation in acids at 96 and 97 per cent previously cooled down to − 10°. The crystals of pure monohydrated acid, thus obtained are drained. The purity of the acid obtained depends on the number of successive crystallisations which it has undergone and on the temperature at which it has been drained. If this has been done at too low a point there is only a very small quantity of mother-liquor, which, consequently, cannot carry away all the impurities.

The Harmlessness of Lead. — An anonymous pamphlet which has appeared at Leipzig contends that leaden water pipes are perfectly safe.

Combination-Heats of the Ammonium Compounds.—Dr. D. Tommasi.—The author gives in parallel columns tables of the combination heats as found experimentally and as calculated according to his law, showing generally a close agreement.

No. 12, March 22, 1884.

The Cholera and Cats.—According to the *Journal d'Hygiene* cats in India are sometimes attacked by choleraic disease, and may communicate it to human beings.

Death of M. Boutigny.—This distinguished physicist, well-known for his researches on the spheroidal state of liquids, died on March 17th, in his 86th year.

The Bethelot-Tommasi Incident.—At the session of the Academy, March 18th, M. Tommasi requested M. Bertrand, the Perpetual Secretary, to present to the Academy a certain memoir. M. Bertrand remarked that the debate between the two chemists threatened to become indefinitely prolonged, and that before inserting M. Tommasi's memoir in the *Comptes Rendus* he should consider it useful to submit the paper to some chemist connected with the Academy. So saying he handed the document to M. Berthelot! As a consequence easy to be foreseen the memoir has not appeared.

The Law of Thermic Substitution Constants.—Dr. D. Tommasi.—In a former note laid before the Academy, the author has shown by various instances that his law is applicable not merely to the salts of mercury and lead, but to all soluble salts without exception. M. Berthelot finds nothing to object to as far as the salts of magnesium, zinc, copper, lead, &c., are concerned, but he points out as exceptions mercury, bromide, cyanide, and acetate. As regards the first of these cases M. Tommasi argues that the assumed formation-heat of mercury bromide, 48·5, is not exact, and that a re-determination is required. The discrepancy as regards mercury cyanide is due, not to the dissociation of the dissolved mercuric cyanide, but to the partial decomposition of the potassium cyanide, which the author employed in calculating the combination-calories of dissolved mercuric cyanide. As for mercuric acetate, the number of calories disengaged on its formation, according to M. Bethelot (6), is evidently too small and cannot be admitted. To this memoir is appended a table of the combination-heat of the compounds of hydroxyl-ammonium as predicted according to the law of M. Tommasi.

No. 13, March 29, 1884.

M. Hallez, a naval lieutenant, stationed at Madagascar sends to the "International Society of Electricians" an account of the daily storms which rage there. The soil of the island is very ferruginous, and in approaching it the compass undergoes considerable and totally abnormal variations. Hence it is suggested that Madagascar may be an enormous magnet.

Combination-Heats of the Compounds of Ethyl-ammonium.— Dr. D. Tommasi.—A table of combination-heats as predicted by the author's law.

No. 14, April 5, 1884.

Combination-Heats of the Compounds of Trimethyl-ammonium.—Dr. D. Tommasi.—The author gives the combination-heats of trimethyl-ammonium sulphate, carbonate, and acetate as calculated and as found experimentally, and a series of heats as calculated but not yet verified experimentally.

MEETINGS FOR THE WEEK

Tuesday, 10th.—Royal Medical and Chirurgical, 8.
—— Photographic, 8.
Wednesday, 11th.—Geological, 8.
—— Microscopical, 8
Thursday, 12th.—Royal, 4.30.
Friday, 13th.—Royal Institution, 8. "Researches on Liquefied Gases," by Professor Dewar, at 9.
—— Astronomical, 8.
—— Quekett Microscopical Club, 8.
Saturday, 14.—Physical, 3. "On the Velocity of Sound in Tubes,' by D. J. Blaikley. "On a New Apparatus for Colour Combinations," by H. H. Hoffert.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1281.

β-NAPHTHAQUINONE.*

By CHARLES E. GROVES, F.R.S.

IN a preliminary notice read before the Society some time ago (CHEMICAL NEWS, vol. xlv., p. 267) on methods of preparing β-naphthaquinone, with especial reference to the value of "β-naphthol orange," the sodium salt of the diazo-sulphonic acid, $OH.C_{10}H_6.N_2.C_6H_4.SO_3H$, recommended by Liebermann as the most convenient source from which to prepare the quinone, the author mentioned that he had carefully repeated Liebermann's experiments, and although he could fully corroborate his statements as to the results obtained, he did not agree with him as to the value of the method for preparing β-napthaquinone.

In the present paper full details are given of the processes for preparing amido-β-naphthol hydrochloride from the "β-orange" by reduction with stannous chloride and also with alkaline sulphides, alluded to in the preliminary notice. Although interesting theoretically, this process is far inferior in simplicity and economy to the one originally proposed by Stenhouse and the author (*Journ. Chem. Soc.*, 1877, ii., 47; and 1878 *Trans.*, 415), which consisted in preparing nitroso-β-naphthol from β-naphthol by the action of nitrosyl sulphate, and then reducing the barium derivative of this by ammonium sulphide. At the present time nearly pure sodium nitrite is made on the large scale for use in the coal-tar colour industry, and it is obviously an advantage to substitute a commercial article like this for nitrosyl sulphate, which has to be made in the laboratory. The method of preparing the nitroso-naphthol now adopted by the author consists in pouring a dilute solution of sodium β-naphthol and sodium nitrite in the proper proportions into dilute sulphuric acid, collecting the yellow precipitate, and purifying it by dissolving it in dilute soda solution, and precipitating it as sodium nitroso-β-naphthol by the addition of more soda, the sodium derivative being but sparingly soluble in solutions containing 2 to 3 per ct. of NaHO. This sodium compound, when introduced in the moist state into a solution of stannous chloride in hydrochloric acid, is at once converted into amido-β-naphthol hycrochloride; care, however, must be taken to avoid any great excess of the stannous salt, otherwise amido-β-naphthol stanno-chloride will be formed instead of the simple hydrochloride.

β-Naphthoquinone.—In order to convert the amido-derivative into the quinone it is better to employ ferric chloride as the oxidising agent instead of the chromic mixture formerly recommended (*loc. cit.*), as it can be used in considerable excess, and allowed to remain in contact with the quinone for some time without altering it, whereas, with chromic mixture, it soon becomes altered and acquires a brown colour. When a dilute solution of amido-β-naphthol hydrochloride is poured into a solution of ferric chloride slightly in excess of the proportion indicated by the equation—

$$OH.C_{10}H_6.NH_3Cl+Fe_2Cl_6+H_2O= \\ =C_{10}H_6O_2+2FeCl_2+NH_4Cl+2HCl,$$

the mixture becomes momentarily darker in colour, and immediately afterwards deposits the quinone in orange-yellow microscopic needles: these have to be carefully washed, and dried at a gentle heat in an atmosphere free from acid fumes, which would darken the quinone from formation of dinaphthyl-diquinhydrone. β-naphthaquinone obtained in this way is pure, and of a deep golden colour, the yield being from 70 to 72 per cent of the amido-hydrochloride employed. As already pointed out, this process has two advantages over Liebermann's; firstly, it is much simpler; and secondly, the cost for raw material to produce a given weight of the quinone is reduced to about one-fifth.

Nitro-β-naphthaquinol, $C_{10}H_5(NO_2)(OH)_2$.—In a former paper (*loc. cit.*) it was mentioned that two compounds, apparently nitro-β-naphthaquinol and amido-β-naphthaquinol, were obtained by the action of hydriodic acid and phosphorus on the nitroquinone. They are, however, more conveniently prepared by the employment of stannous chloride as the reducing agent. When moist nitro-β-naphthaquinone is introduced into a somewhat dilute solution of stannous chloride (containing 4 to 5 per cent of tin) in the proper proportions, a considerable portion of the nitro-derivative dissolves, forming a deep red liquid; but in a few minutes it again becomes paler, and the amido-quinol separates in the crystalline state. It is almost insoluble in water, but may be crystallised from alcohol or benzene, when it forms brilliant red scales, quite different from the substance of the same composition obtained by Korn from nitro-β-naphthaquinon-anilide (*Berichte*, 17, 909).

Amido-β-naphthaquinol.—Nitro-β-naphthaquinone is converted into the amido derivative by submitting it to a more energetic reducing action, such as tin and hydrochloric acid, or a hot concentrated solution of stannous chloride. It is far better, however, to convert it first into the nitro-β-naphthaquinol, and to mix the crystals while still moist with finely-divided tin—such as is obtained by precipitation—and strong hydrochloric acid. On gently heating the mixture in a water-bath a violent reaction sets in, which, if the quantity operated on is large, must be moderated by plunging the beaker into cold water. The red colour rapidly disappears, and, on cooling, the amido-β-naphthaquinol hydrochloride is deposited in the crystalline state, and may be purified by re-crystallisation from hot water, when it forms pale yellow prisms. Like the amido-β-naphthol-compound, it is quickly oxidised on exposure to the air.

In conclusion, the author drew attention to the fact that although in a paper published in conjunction with the late Dr. Stenhouse he had mentioned the production of amido-β-naphthaquinone by the action of reducing agents, and more recently in a notice in the *Berichte* especially addressed to Prof. Liebermann, he had stated that he was engaged in an investigation "of nitro-β-naphthaquinone and the products obtained from it by the action of reducing agents" (*Berichte*, 14, 1659), a student in the "Org. Laboratorium d. tech. Hochschule," working under Prof. Liebermann's direction, has recently published a note in which he describes the reduction of nitro-β-naphthaquinone to amido-β-naphthaquinone without the slightest reference to its having been already done.

* Abstract of a Paper read before the Chemical Society.

OXY-CELLULOSE AND PHENYL-HYDRAZINE.

By C. F. CROSS and E. J. BEVAN.

IN a recent number of the *Berichte Deut. Chem. Gesell.* (1884, p. 572), there is a paper by Fischer on the reactions of the salts of phenyl-hydrazine with aldehyds and ketones of both the aromatic and fatty groups. Amongst the reactions specially described are those of the aldehydic sugars, but no mention is made of experiments with the more complicated members of the carbohydrate group, *e.g.*, the cellulose and their immediate derivatives. We are therefore extending this reaction, which appears to be generally characteristic of the aldehyds and ketones, to the examination of the large group of the celluloses and their derivatives. Thus far we have found that the oxy-celluloses described by Witz and ourselves* give a deep

* *Bull. Soc. Ind. Rouen*, 1883, 169 and 240; *Chem. Soc. Journ.*, Jan., 1883, 22.

yellow colouration when warmed with a solution of the hydrochloride of the base; lignose, on the other hand, a dull yellow, contrasting strongly with the bright yellow which it gives with aniline sulphate. These reactions are characteristic, and we recommend them to the attention of those who are working in this field of research.

THE ACTION OF ARSENIOUS ANHYDRIDE UPON GLYCERIN.

By HERBERT JACKSON.

FOLLOWING out a suggestion made to me by Professor Bloxam, I have recently examined the action which takes place when glycerin is saturated with As_2O_3. It is stated in several books that glycerin is the best solvent for As_2O_3, but the reason of this has, so far as I am aware, never been pointed out. I found that a considerable quantity of water was given off when anhydrous glycerin was treated with dry As_2O_3, and I directed my attention in the first place to the determination of the amount of water evolved when a weighed quantity of glycerin was treated with excess of As_2O_3. Some preliminary experiments had shown that the As_2O_3 would be in sufficient excess if used in the proportion of 1·5 parts of As_2O_3 to 1 part of glycerin. I found considerable difficulty in obtaining constant results in the determination of the water; but the mean of several experiments (viz., 25·5 grms. of glycerin gave 8·1 grms. of water) indicated that the amount of As_2O_3 required to saturate the glycerin was at least equal in weight to the glycerin employed. The next experiments were arranged to determine the maximum quantity of As_2O_3 which could be made to combine with glycerin. For this purpose different proportions of glycerin and As_2O_3 were taken and placed in stout hard glass tubes, the ends of which were then sealed, and the tubes with their contents were heated in an air-bath for two hours at a temperature of 230° C.

It was found that in all cases where the amount of As_2O_3 had been greater than that indicated by the previous experiments (viz., 1 part of As_2O_3 to 1 part of glycerin), some of the As_2O_3 crystallised out as the tubes cooled. Some blackening of the contents was noticed in each instance; this was found on examination to be due to arsenic from reduction of a little As_2O_3. After these experiments I made some more determinations of the amount of water evolved when a weighed quantity of glycerin was treated with As_2O_3, and of the weight of As_2O_3 required to fully saturate it. The mean of these experiments gave the following result:—18·45 grms. of glycerin required for saturation 19·98 grms. of As_2O_3 and gave off 4·37 grms. of water, or nearly; 184 parts (2 equivalents) of glycerin require 198 parts (1 equivalent) of As_2O_3, and evolve 54 parts (3 equivalents) of water, represented by the equation—

$$2C_3H_5(OH)_3 + As_2O_3 = 2C_3H_5AsO_3 + 3H_2O.$$

The mean of the analyses of the products obtained in the last experiments gave the following result:—0·2221 grm. of the compound contained 0·1225 grm. of As_2O_3: 0·2221 grm. of $C_3H_5AsO_3$ contains theoretically 0·1225 grm. As_2O_3. These experiments prove that As_2O_3 and glycerin react together to form normal glyceryl arsenite or the arsenious ether of glycerin, in the manner represented by the above equation. This compound is a colourless, transparent, vitreous solid, very deliquescent, and easily decomposed by water into glycerin and As_2O_3. It is entirely soluble in absolute alcohol, and is left unchanged when the alcohol is driven off by evaporation. It is also freely soluble in glycerin, as would be expected. It becomes soft at 100° C., and can be poured easily when the temperature reaches 200° C. When quite dry it appears to be stable at the boiling-point of glycerin, 290° C., but is decomposed above that temperature.

King's College, Chemical Laboratory,
London, June 2, 1884.

MOLECULAR COMPOUNDS OF CALCIUM.

By CHARLES W. FOLKARD, Assoc. R.S.M.

IN an attempt to prepare and isolate the particular sulphide of calcium which is capable of combining with bisulphide of carbon vapour, a series of compounds were obtained, which, so far as I am aware, have not yet been described, and they are the more interesting inasmuch as bleaching-powder appears to have a somewhat analogous constitution.

On passing a mixture of dry hydrogen and sulphuretted hydrogen (the gas obtained by acting on ferrous sulphide with dilute sulphuric acid) over hydrate of calcium for some hours until no more gain of weight is observed, a grey powder is obtained consisting of CaH_2O_2 and H_2S in a very feeble state of combination, the CaH_2O_2 increasing in weight about 32 to 33·5 per cent. This corresponds nearly to the equation—

$$4CaH_2O_2 + 3H_2S = 4CaH_2O_2.3H_2S.$$

On passing coal-gas over this compound H_2S is evolved, and by raising the temperature to 100° C. H_2O is eliminated and a grey green salt is left.

$$4CaH_2O_2.3H_2S = \left\{\begin{matrix} CaH_2O_2 \\ CaH_2O_2 \\ CaO.H_2S \\ CaO.H_2S \end{matrix}\right. + H_2S + 2H_2O.$$

The grey green compound by a gentle heat in a stream of coal-gas loses H_2O, leaving a yellowish white salt of the composition—

$$\left\{\begin{matrix} CaH_2O_2 \\ CaH_2O_2 \\ CaO.H_2S \\ CaS \end{matrix}\right.$$

By a red heat (air being excluded) $2H_2O$ are eliminated, leaving a compound of the formula—

$$\left\{\begin{matrix} 2CaO \\ CaO.H_2S \\ CaS \end{matrix}\right.$$

which, when ignited in air, glows and burns like tinder, $CaSO_4$ being formed.

These bodies are probably molecular compounds of hydrate and oxy-hydrosulphide of calcium, and if this be the case bleaching-powder may have a constitution represented by the formula—

$$2CaH_2O_2 + Cl_2 = \left\{\begin{matrix} CaH_2O_2 \\ CaO.Cl_2.H_2O \end{matrix}\right.$$

it being well known that the lime absorbs only 50 per cent of its weight of chlorine, which agrees fairly well with the above. It is unfortunate, however, from a manufacturing point of view that there is apparently no chlorine analogue of the sulphuretted compound—

$$\left\{\begin{matrix} 4CaH_2O_2 \\ 3H_2S \end{matrix}\right.$$

otherwise there would be a possibility of forming a "bleach" containing 56 per cent of available chlorine.

The above compounds are rational, and their constitution may be expressed by graphic formulæ in which sulphur is a hexad (the molecules of CaH_2O_2 being separate).

The grey green salt was analysed with the following results:—

	Theory.	Obtained.
Ca_4	48·8	48·5
S_2	19·5	18·9
$(H_2O)_3$	16·5	16·7
O_2 for Ca_2	9·7	10·0 (calculated from Ca and S found).
H_2O not expelled by red heat	5·5	5·9 (by difference).
	100·0	100·0

Chiswick, W., May 29, 1884.

ON THE SEPARATION AND DETERMINATION OF LIME EVEN IN THE PRESENCE OF A LARGE EXCESS OF ALUMINA MAGNESIA, FERRIC OXIDE, AND PHOSPHORIC ACID.

By M. ANTONY GUYARD.

Alumina, ferric oxide, lime, and the phosphates of these bases are, as is known, soluble in ammoniacal ammonium citrate. The author finds that on employing as nearly as possible only the quantity of ammonium citrate necessary to keep these bodies in a state of perfect solution, the lime is easily and completely precipitated by means of ammonium oxalate. The calcium oxalate thus obtained may be ignited and weighed directly.

When the mixture, as is observed in the analysis of soils, contains a little soluble silica, this is partially precipitated, and carries down with it a little iron and alumina, and it is necessary to purify the precipitate before proceeding with the operation.

The presence of magnesia does not interfere with the direct determination of the lime as proposed. It is merely necessary to effect the precipitation at 70° to 80°, so that the ammoniacal magnesium phosphate which would be thrown down in the cold may remain in solution.

After the separation of the lime nothing prevents the determination of the magnesia by means of phosphoric acid, or of phosphoric acid by means of magnesia. The simple process just described can receive a number of applications in analysis. It is more convenient than the usual method, which consists in transforming the mixtures of lime, magnesia, alumina, ferric oxide, and phosphoric acid, into acid acetates, and is much more accurate.

Calcium oxalate is soluble in free acetic acid, even when dilute, in a quantity proportional to the quantity of free acetic acid and of acetates present. To obtain a complete precipitation of the lime it is necessary to add sufficient ammonium oxalate to convert the acetates into oxalates. Even then the precipitation of the lime is not perfect.—*Bulletin de la Société Chimique.*

SPONTANEOUS DECOMPOSITION OF EXPLOSIVE GELATIN.

By CHARLES E. MUNROE, S.B. (Harv.).

Several instances of the decomposition of explosive gelatin, on keeping or after long exposure to moderate temperatures, have been reported, but I have yet met with but one of these cases in which the products of the decomposition have been stated. Genl. H. L. Abbot, in a prefatory note to Addendum I. Report on Submarine Mines, states that "all the samples of the explosive gelatin remaining on hand after the trials detailed in the Report have undergone spontaneous decomposition, separating into cellulose and free nitro-glycerin with the copious evolutions of nitrous fumes. This change occurred during the winter and spring of the current year (1881—1882), and was not caused by any exposure to high temperatures while in store."

A case of spontaneous decomposition of a small amount stored freely exposed to the air, in a room of fairly even temperature and dryness, has occurred under my own observation. The camphorated explosive gelatin was wrapped in paraffin paper, and then in light brown Manilla pa per, and laid on the shelf. After something more than one year's exposure it was found, in the early winter, to be giving off nitrous fumes (which had stained and attacked the wrapping paper), and to have shrunk considerably in volume, while the outside of the paper was covered with congeries of fine crystals. The odour of camphor was still quite strong. The mass was immediately put into a vessel of water. It was found to be friable, and, after a short immersion, disintegrated. The camphor odour soon disappeared, and the water became of a straw colour, gave a strong acid reaction, and showed traces of nitrous acid, but no nitric acid. On evaporation of the filtered liquid, oxalic acid crystallised out in quantity, and on evaporation of the "mother-liquor" on the water-bath a sugar-like mass was obtained, which gave the glucose reaction with Fehling's solution. The paraffin was regained unchanged, and the paper was recovered, but in a flocculent condition, and with the colour bleached from the brown. Careful search failed to reveal the presence of glycerin, nitro-glycerin, or gun-cotton. The cellulose from the gun-cotton could not well be detected (if it existed) in the presence of so much flocculent cellulose from the paper. In reporting these observations I am not unmindful of the fact that some changes may have taken place during immersion, but it can easily be understood why I preferred it in that position.

The results obtained by De Luca in his "Researches on the Spontaneous Decomposition of Gun-Cotton" (*Comptes Rendus*, 59, 487, Sept. 12, 1847) are interesting in this connection. Gun-cotton decomposes most rapidly when heated to 50° on a water-bath, next by direct sunlight, more slowly by diffused light, and very slowly in darkness. The gun-cotton first shrinks to one-tenth of its original volume, next it begins to become gum-like and sticky, then it swells; during all these phases it gives off nitrous fumes, but especially during the last. For the fourth phase the gas ceases to be evolved, and the mass becomes brittle, and of a light colour like sugar. The products are nitrous compounds, with formic and acetic acids in the state of a gas, and an amorphous, porous, sugar-like body, almost entirely soluble in water, and containing an abundance of glucose, gummy matter, oxalic acid, a small quantity of formic acid, and a new acid of which he obtained the lead and silver salts for later examination. From 100 grains of gun-cotton he obtained about 14 grains of glucose.

In discussing the stability of nitro-glycerin (which is the other component of explosive gelatin), A. Brull, in "Etudes sur la Nitro-glycérin et la Dynamite," fig. 26, 1875, says, "Nitro-glycerin which retains traces of acid is not stable. In general the decomposition is extremely slow and tranquil. It disengages at first nitrous fumes, and the liquid takes a greenish colour: then it generates nitrogen protoxide, carbon dioxide, and crystals of oxalic acid; and after some months the entire mass is found to be converted into a greenish, gelatinous mass, composed of oxalic acid, water, and ammonia. Sometimes, if the temperature is quite high,—if, for example, the nitroglycerin is heated by the sun,—the decomposition is more active. Very rarely it causes an explosion.

The source of difficulty, then, seems to be in the presence of free acid, and this will probably be found in the gun-cotton used, for it is difficult to purify soluble guncotton completely.—*Journal of the American Chemical Society*.

SAMARSKITE, FROM BERTHIER COUNTY, QUE.*

By J. T. DONALD, M.A.

In September last Mr. David Aikman of this city sent me for examination a specimen of a hard, heavy, brownish black mineral which he had found in the township of Brassard, County of Bertheir, Que. On examining this mineral with the blowpipe I thought it must be either columbite or tantalite. Its specific gravity 5·305 (or, from a fragment sent to Mr. J. H. Burland, 5·1142) led to the belief that it was the former. At the time I could not

* Read before the Natural History Society, Montreal, Jan., 1884.

learn that this mineral had hitherto been found in Canada, but on writing to Mr. C. C. Hoffman, Chemist and Mineralogist to the Geological Survey, I learned that a specimen had been obtained from the very same locality by officers of the Survey, and had been analysed by Mr. Hoffman, whose analysis showed it to be the species Samarskite.

Mr. Hoffman published a report of his analysis in the *American Journal of Science* early last year, and in his report (as yet unpublished) to the Director of the Survey, writes as follows:—

"*Samarskite.*

"This interesting mineral—not hitherto met with in Canada—was found just beyond the north-western limits of the Township of Brassard, County of Berthier, P.Q.

"It consisted of irregular-shaped fragments without the slightest indication of crystalline form; lustre, submetallic, shining; colour, brownish-black, almost black; in parts iridescent; opaque even on the thinnest edges; brittle; fracture, uneven; streak, greyish brown; hardness, about 6; fuses between 4 and 4·5; specific gravity, 4·9478. In the closed tube decrepitates and gives off a little slightly acid water. Readily and completely decomposed by heating with concentrated sulphuric acid. Analysis gave—

Columbic acid .. .. }	55·41 *
Tantalic acid .. .. }	
Tungstic acid	—
Stannic acid..	0·10
†Yttrium oxide	14·34
†Cerium oxide	4·78
Uranium oxide (UO_3)..	10·75
Manganous oxide	0·51
Ferrous oxide	4·83
Lime	5·38
Magnesia	0·11
Potash	0·39
Soda	0·23
Fluorine..	trace
Water	2·21
	99 04

* Apparently in great part, if not almost entirely, columbic acid.
† The presence or absence of other members of this group was not ascertained.

"A gramme of the finely pulverised mineral, decomposed by heating with sulphuric acid, with careful exclusion of air, decolourised an amount of potassium permanganate corresponding to 4·79 per cent ferrous oxide. The water was expelled by ignition, and collected in a chloride of calcium tube."

Mr. Aikman's specimen is, in physical characters, very similar to that analysed by Mr. Hoffman, differing only in the higher specific gravity. Mr. Aikman informs me that this mineral is not at all rare in the locality mentioned; it was seen scattered through the gneiss in several places in irregular patches from six to eight inches in length. It is interesting to note that this mineral, containing so large a proportion of the metals columbium, tantalum, uranium, cerium, and yttrium, is so abundant in the locality cited.—*Canadian Record of Natural History and Geology.*

Conditions proper for Accelerating the Oxidation of Drying Oils.—A. Livache.—The author finds that whilst an ordinary drying oil containing lead dries in 24 hours, a similar oil containing manganese dries under the same conditions in 5 to 6 hours. Copper, zinc, cobalt, nickel, iron, chrome, &c., prolong the time of drying to 36 to 48 hours. In practice he takes an ordinary lead oil, adds to it dry manganese sulphate in fine powder, and agitates for some time in the cold. The manganese is entirely substituted for the lead, and the oil obtained, freed from dregs by simple decantation, possesses an extreme drying power.—*Les Mondes*, No. 14.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ZIRCONIUM.

The atomic weight of zirconium has been determined by Berzelius, by Hermann, and by Marignac. Berzelius† ignited the neutral sulphate, and thus ascertained the ratio in it between the ZrO_2 and the SO_3. Putting SO_3 at 100, he gives the following proportional quantities of ZrO_2:—

75·84
75·92
75·80
75·74
75·97
75·85

Mean 75 853 $\pm$ 0·023

Hence Zr=89·255 $\pm$ 0·039; or, if O=16, then Zr=89·461.

Hermann's‡ estimate of the atomic weight of zirconium was based upon analyses of the chloride, concerning which he gives no details or weighings. From sublimed zirconium chloride he finds Zr=831·8, when O=100; and from two lots of the basic chloride $2ZrOCl_2 9H_2O$, Zr=835·65 and 851·40 respectively. The mean of all three is 839·62; whence, with modern formulæ and O = 15·9633, Zr becomes=89·354.

Marignac's results‖ were obtained by analysing the double fluoride of zirconium and potassium. His weights are as follows:—

1·000 grm. gave	0·431 grms. ZrO_2 and	0·613 grm. K_2SO_4.	
2·000 ,,	0·864 ,,	1·232 ,,	
0·654 ,,	0·282 ,,	0·399 ,,	
5·000 ,,	2·169 ,,	3·078 ,,	

These figures give us three ratios. A, the ZrO_2 from 100 parts of salt; B, the K_2SO_4 from 100 parts of salt; and C, the ZrO_2 proportional to 100 parts of K_2SO_4:—

	A.	B.	C.
	43·100	61·300	70·310
	43·200	61·600	70·130
	43·119	61·000	70·677
	43·380	61·560	70·468
Mean	43·200 $\pm$ 0·043	61·365 $\pm$ 0·094	70·396 $\pm$ 0·079

From A	Zr=89·775 $\pm$	0·216
,, B	,, 91·408	0·437
,, C	,, 90·476	0·138
General mean ..	,, 90·328	0·113

Or, if O=16, Zr=90·536.

Combining with Berzelius's work we get this result:—

Berzelius	Zr=89·255 $\pm$	0·039
Marignac	,, 90·328	0·113
General mean ..	,, 89·367	0·037

Or, if O = 16, Zr = 89·573.

These figures need little criticism. They show conclusively that the atomic weight of zirconium ought to be redetermined. Probably the method employed by Berzelius was the best with respect to manipulation, while, on the

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 4, 126. 1825.
‡ *Journ. f. Prakt. Chem.*, 31, 77. *Berz. Jahresb.*, 25, 147.
‖ *Ann. Chim. Phys.*, (3), 60, 270 1860.

other hand, it is likely that Marignac worked with purer material. Hermann's experiments could hardly have yielded certain results, since the zirconium chloride might so easily become contaminated with traces of moisture and thence of oxygen.

THORIUM.

THE atomic weight of thorium has been determined from analyses of the sulphate, oxalate, formate, and acetate, with widely varying results. The earliest figures are due to Berzelius,* who worked with the sulphate, and with the double sulphate of potassium and thorium. The thoria was precipitated by ammonia, and the sulphuric acid was estimated as $BaSO_4$. The sulphate gave the following ratios in two experiments. The third column represents the weight of ThO_2 proportional to 100 parts of $BaSO_4$:—

0·6754 grm. ThO_3	= 1·159 grms. $BaSO_4$.	Ratio 58·274
1·0515 ,,	1·832 ,,	,, 57·396

The double potassium sulphate gave 0·265 grm. ThO_2, 0·156 grm. SO_3, and 0·3435 K_2SO_4. The SO_3, with the Berzelian atomic weights, represents 0·4537 $BaSO_4$. Hence 100 $BaSO_4$ is equivalent to 58·408 ThO_2. This figure, combined with the two previous values for the same ratio, give a mean of 58·036 ± 0·214. Hence ThO_2 = 269·940 ± 0·997.

From the ratio between the K_2SO_4 and the ThO_2 in the double sulphate, ThO_2 = 268·284.

In 1861 new determinations were published by Chydenius,† whose memoir is accessible to me only in an abstract‡ which gives results without details. Thoria is regarded as a monoxide, ThO, and the old equivalents (O = 8) are used. The following values are assigned for the molecular weight of ThO, as found from analyses of several salts:—

From Sulphate.	From K. Th. Sulphate.
66·33	67·02
67·13	
67·75	
68·03	

Mean 67·252 ± 0·201

From Acetate.	From Formate.	From Oxalate.
67·31	68·06	65·87 } Two results
66·59	67·89	65·95 } by Berlin.
67·27	68·94	65·75
67·06		65·13
68·40	Mean 68·297 ± 0·219	66·54
		65·85
Mean 67·326 ± 0·201		Mean 65·85 ± 0·123

We may fairly assume that these figures were calculated with O = 8, C = 6, and S = 16. Correcting by the values for these elements which have been found in previous chapters, ThO_2 becomes as follows:—

From sulphate	ThO_2 = 268·584	± 0·803
,, acetate	,, 268·735	0·805
,, formate	,, 272·586	0·877
,, oxalate	,, 262·804	0·493

The single result from the double potassium sulphate is included with the column from the ordinary sulphate, and the influence of the atomic weight of potassium is ignored.

Chydenius was soon followed by Marc Delafontaine, whose researches appeared in 1863.‖ This chemist especially studied thorium sulphate; partly in its most hydrous form, partly as thrown down by boiling. In $Th(SO_4)_2.9H_2O$, the following percentages of ThO_2 were found:—

45·08
44·90
45·06
45·21
45·06

Mean 45·062 ± 0·0332

Hence ThO_2 = 263·637 ± 0·256.

The lower hydrate, $2Th(SO_4)_2.9H_2O$, was more thoroughly investigated. The thoria was estimated in two ways; first, (A), by precipitation as oxalate and subsequent ignition; second, (B), by direct calcination. These percentages of ThO_2 were found:—

52·83 }
52·52 } A.
52·72 }
52·13 }
52·47 }
52·49 }
52·53 }
52·13 }
52·13 } B.
52·43 }
52·60 }
52·40 }
52·96 }
52·82 }

Mean 52·511 ± 0·047

Hence ThO_2 = 266·025 ± 0·363

In three experiments with this lower hydrate the sulphuric acid was also estimated, being thrown down as barium sulphate after removal of the thoria:—

1·2425 grms. gave	0·400 SO_3.	(1·1656 grms. $BaSO_4$.)
1·138 ,,	0·366 ,,	(1·0665 ,,)
0·734 ,,	0·2306 ,,	(0·6720 ,,)

The figures in parenthesis are reproduced by myself from Delafontaine's results, he having calculated his analyses with O = 100, S = 200, and Ba = 857. These data may be reduced to a common standard, so as to represent the quantity of $2Th(SO_4)_2.9H_2O$ equivalent to 100 parts of $BaSO_4$. We then have the following results:—

106·597
106·704
109·226

Mean 107·509 ± 0·585

Hence ThO_2 = 259·555 ± 2·725

Delafontaine seems himself to have calculated from the ratio between the percentages of SO_3 and ThO_2; whence, with our revised values for S, Ba, and O, ThO_2 = 262·643.

Delafontaine's work was soon confirmed by Hermann,* who published a single analysis of the lower hydrated sulphate, as follows:—

ThO_2	52·87
SO_3	32·11
H_2O	15·02
	100·00

Hence, from the ratio between SO_3 and ThO_2, ThO_2 = 263·030. Probably the SO_3 percentage was lost upon calcination.

The latest, and probably also the best determinations, are those of Cleve,† whose results, obtained from both the

* *Poggend. Annal.*, 16, 398. 1829. "Lehrbuch," 3, 1224.
† Kemisk undersökning af Thorjord och Thorsalter. Helsingfors, 1861. An academic dissertation.
‡ *Poggend. Annal.*, 119, 55. 1863.
‖ *Arch. des Sci. Phys. et Nat.* (2), 18, 343.

* *Journ. f. Prakt. Chem.*, 93, 114.
† *K. Svenska Vet. Akad. Handlinger.* Bd. 2, No. 6 1874.

sulphate and the oxalate of thorium, agree admirably. The anhydrous sulphate, calcined, gave the subjoined percentages of thoria :—

62·442
62·477
62·430
62·470
62·357
62·366

Mean 62·423 ± 0·014

Hence ThO_2=265·380 ± 0·123.

The oxalate was subjected to a combustion analysis, whereby both thoria and carbonic acid could be estimated. From the direct percentages of these constituents no accurate value can be deduced, there having undoubtedly been moisture in the material studied. From the ratio between CO_2 and ThO_2, however, good results are attainable. This ratio I put in a fourth column, making the thoria proportional to 100 parts of carbon dioxide :—

Oxalate.	ThO_2.	CO_2.	Ratio.
1·7135 grms.	1·0189 grms.	0·6736 grm.	151·262
1·3800 ,,	0·8210 ,,	0·5433 ,,	151·114
1·1850 ,,	0·7030 ,,	0·4650 ,,	151·183
1·0755 ,,	0·6398 ,,	0·4240 ,,	150·896
		Mean	151·114 ± 0·053

Hence ThO_2=265·357 ± 0·104.

There are now before us twelve estimates for the molecular weight of thoria. Two of these represent single experiments, and have no probable error attached to them; namely, the one due to Hermann, and the one deduced from Berzelius's K_2SO_4 : ThO_2 ratio. A third value, from Delafontaine's sulphuric acid estimations, has so high a probable error that it could be rejected without influencing the general mean. These three values might all be excluded without serious objection; but it is perhaps better to arbitrarily assign them equal weight, average them together, and give their mean the same probable error as that which attaches to Berzelius's $BaSO_4$: ThO_2 series. This mean is indicated as "A" in the following combination :—

Value "A"	ThO_2=	263·623 ±	0·997
Berzelius	,,	269·940	0·997
Chydenius—Sulphate	,,	268·584	0·803
,, Acetate	,,	268·735	0·805
,, Formate	,,	272·586	0·877
,, Oxalate	,,	262·804	0·493
Delafontaine—Higher hydrate ..	,,	263·637	0·256
,, Lower ,, ..	,,	266·025	0·363
Cleve—Sulphate	,,	265·380	0·123
,, Oxalate	,,	265·357	0·104
General mean	,,	265·341	0·072

Hence Th=233·414 ± 0·0725; or, if O=16, Th=233·951.

These values vary from those derived from Cleve's experiments alone only in the second decimal.

The following additional note has been communicated by the author :—

Since the foregoing chapter was first printed, a more exact determination of the atomic weight of thorium has been made by Nilson.* First, crystallised thorium sulphate (with $9H_2O$) was ignited. In six experiments the mean percentage of thoria thus obtained was 45·0905 ± 0·0019. Second, anhydrous thorium sulphate was ignited. In four experiments a mean percentage of thoria of 62·2975 ± 0·0008 was found.

* Berichte, 15, 2527. 1882.

From the first series of experiments, ThO_2 = 263·941 ± 0·039
,, second ,, ,, 263·959 0·053

General mean .. 263·947 ± 0·032

Hence, Th = 232·020 ± 0·032.

As Nilson is probably the first chemist to work with absolutely pure thorium compounds, this atomic weight determination must be regarded as supplanting all previous ones.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, June 5, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (June 19th).

The following certificates were read for the first time :— F. Broughton, F. J. Down, J. Hulme, F. G. Holmes, C. Thompson, W. F. Wyley.

Mr. C. E. Groves then read a paper "*On Beta-naphthaquinone.*" An abstract of this paper appears on page 257.

The two following papers were then read by the Secretary :—

"*On a By-product of the Manufacture of Aurin* (Part II.)," by A. Staub and Watson Smith. In a previous paper it was shown that the product in question, phenyl-ortho-oxalic ether, was formed by the direct union of two molecules of phenol with one of anhydrous oxalic acid. The authors have prepared a perfectly pure specimen by repeated re-crystallisation from glacial acetic acid, and an analysis agrees with the formula $C_{14}H_{14}O_6$. Analogous compounds with α- and β-naphthols have been obtained, but no corresponding body could be obtained with resorcinol. The melting-point of the phenyl-ortho-oxalate was found to be 126° to 127°. When heated with strong sulphuric acid aurin is obtained. If phenol be present the yield of aurin is not increased. Only traces of formic acid are evolved during the reaction. The authors conclude that the ortho-phenyl-oxalate plays no part as an intermediate product in the formation of aurin. They also prove that not a trace of aurin is formed by the action of nascent carbon dioxide on phenol.

"*On Calcium Hydrosulphides,*" by E. Divers and Tetsukichi Shimidzu, of Tokio. One part of lime, made by igniting precipitated calcium carbonate, is made into a thick paste by mixing with 4 parts of water; hydrogen sulphide is passed through, the lime gradually dissolves, more lime is added until a solution of the hydrosulphide, strong enough to crystallise when cooled, is obtained. The preparation of such a solution may take several days. Air must be completely excluded, and the process is facilitated by cooling. The solution having been prepared is allowed to settle at a slightly warm temperature, so that any crystals which have formed may be dissolved, and then decanted in an atmosphere of hydrogen sulphide. On cooling colourless prismatic crystals of $Ca(HS)_2,6H_2O$ separate out. They are very soluble in water and alcohol, and decompose when heated and when exposed to the air. Analyses are given proving the above composition. When this substance is treated with water or calcium hydrate, calcium hydroxy-hydrosulphide is formed, $CaHSHO,3H_2O$. This body crystallises in colourless four-sided prisms, slowly evolving hydrogen sulphide when exposed to the air. By gently heating the hydrosulphide in a current of hydrogen sulphide, calcium monosulphide mixed with some hydroxide was obtained

as a white amorphous solid. Carbon dioxide decomposes the calcium hydrosulphides, and the authors find that hydrogen sulphide decomposes calcium carbonate; so that carbon dioxide mixed with an excess of hydrogen sulphide may be passed through lime-water without causing a turbidity. Odling states that when calcium hydrosulphide is boiled with sulphur, hydrogen sulphide is liberated. Calcium pentasulphide is formed under these circumstances. The authors show that hydrogen sulphide bubbled through a cold dilute solution of pentasulphide effects the reverse reaction and re-forms the hydrosulphide. In conclusion, the authors have investigated the formation of thiosulphate from the hydrosulphide and the pentasulphide, and they conclude that in both cases it is not a direct oxidation, but that the hydrogen sulphide oxidises, and then by the reaction of its products forms the thiosulphate. They give the following equations:—

$$CaHSHO+2O_2+H_2S=CaS_2O_3+2H_2O.$$
$$CaS_5+2H_2O=CaHSHO+3S+H_2S.$$

The hydrosulphide then reacts with oxygen and the hydrogen sulphide as above.

The Society then adjourned to June 19, when a ballot for the election of Fellows will be held and the following papers read:—"On the Magnetic Rotation of Chemical Bodies in Relation to their Composition and Constitution," by W. H. Perkin, F.R.S.; "On the Effect of High Temperature on Petroleum Hydrocarbons," by Drs. Armstrong and Miller; "On Nitrification" (Part III.), by R. Warington.

NOTICES OF BOOKS.

The Law and Practice of Patents. By CLEMENT HIGGINS, Barrister-at-Law. London: William Clowes and Sons, Limited, 1884.

THE legal changes that have been effected relating to patents for inventions, designs, and trade marks, at the commencement of this year, have occasioned the compilation and publication of a considerable number of treatises explanatory of the new Act. The aims of the various authors of these works are seemingly more or less alike, the analyses of this Act with such notes and citations as might on the one hand be of assistance to intending patentees in making their own application, or, on the other hand, to form standard legal treatises of professional value. The work before us evidently has been written with the view to its taking a place as a concise and comprehensive book of reference to this branch of law, and consequently the number of cases cited in order to render more clear and show the full bearing of the different sections of the Act are very numerous, and the amount of explanatory matter added in the form of notes is great. A special feature of the book is the introduction under the various sections of lengthy paragraphs of "Illustrations," being short accounts of points that have been made the subjects of legal dispute. These examples, which are numerous, together with the full analyses that the author gives of the sections of the new Act, will render the book an invaluable one for reference.

For the assistance of those who are not well versed in legal literature we think that when the next edition of this treatise is published it might be well to add a short note explaining the abbreviations employed in indicating the legal journals and other sources wherein the cases that are cited are reported.

Tokio Daigaku (University of Tokio). The Calendar of the Departments of Law, Science, and Literature, 2542-43 (1882-83). Tokio: Z. P. Maruya and Co.

THE perusal of this little book by an Englishman is apt to flatter his vanity, especially if he knows anything of the order and extent of the courses of study laid down at any of our Universities or the text-books employed in the class rooms. The Japanese certainly do not, like their conservative neighbours the Chinese, regard Europeans as barbarians, or one-eyed mortals, judging by their liberal adoption of foreign educational schemes, and their having, to a certain extent, foreigners to lecture to them in a strange tongue. This exhibition of a liberal spirit is naturally only of a temporary character, arising from the eagerness of a nation living in a country rich in natural resources to utilise a knowledge of the arts and sciences to the material benefit of the race; and although we have here a calendar which, but for the names of the officials and pupils, might represent that of any of our own colleges, the changes that may take place in a few years' time when the English language is discarded and the present race of Japanese students have become philosophers, may necessitate an Oriental scholar to decipher the intricacies of the Japanese educational system.

The University of Tokio, with its four departments of Literature, Law, Medicine, and Science, offers to the studious youths of Japan ample facilities for obtaining a sound professional education, at least so far as the detailed statements of the courses of instruction that are herein given allow us to form an estimate; but however thorough and liberal this education code may appear to our eyes on paper, its suitableness to the intelligence of the people and the benefits likely to be derived from it will only be shown when the system has been worked for some years to come. To be admitted into this Institution the student must be over sixteen years of age and have passed through the courses of study in the Yobimon or preparatory school, or show on examination to have the necessary degree of proficiency to be able to take up profitably the more advanced studies. During the first year the subjects that are taught in each of the departments are of a general nature, serving to form a good foundation for the special courses that follow during the next three years. In the department of science eight such courses are established, of mathematics, physics, chemistry, &c., to any one of which the student is expected to give his whole attention. In the mathematical course during his three years study the student is required to read, in graduated order, such works as those of Todhunter, Williamson, Price, Frost, Salmon, and Boole, together with something of quaternions, elliptic functions, and the mathematical theory of electricity and magnetism. The student who selects physics as his branch of study is exercised in physical manipulations, the use of instruments of precision, and general laboratory work; in the third year electricity and magnetism are the principal studies, with practice in electric and magnetic measurements, telegraph testing, &c., and before the close of the term each student is required to undertake and carry out in the way of original research an investigation to be made the subject of his graduating thesis.

To the mining and metallurgical student every facility is offered for gaining that practical experience which alone makes his studies profitable. The metallurgical laboratory is supplied with small reverberatory, calcining, and several small retorting and smelting furnaces, a stamp battery, rock breaker, hydraulic jigger, &c.; quantities of ores from gold, silver, copper, and other mines being supplied for experimental purposes, and the student is expected to examine and find the best method of their treatment, mechanical as well as metallurgical, and to form estimates of cost of treatment.

In the department of philosophy a wide field is traversed and lectured upon. Several of the subjects to a European student would be highly interesting, especially the history of Oriental philosophy, and the ideas put forth in such books as "Rongo, Mishi, Yoshisauron, Schikiogi, Yuimakio." The text-books on psychology, sociology, and kindred subjects used include the works of Bain, Maudsley, Spencer, Mill, Hume, Lewes, and others.

During his course of studies the student is submitted to

periodic examinations, on the results of which he is either promoted, degraded, or dismissed, according to the number of "marks" he has been able to score, and if he has been so unfortunate as to fail in any examination he is not allowed to be re-examined under any circumstances. Finally, as a reward for having undergone his examinational torture with credit in marks, a degree is granted him according to the subject he has studied. With regard to this matter of degrees we are told that "in early times the system of granting degrees to students existed but had been abandoned for a long time. This re-establishment of the system of granting degrees is to be regarded as a remarkable event in the history of Japanese education."

Journal and Proceedings of the Royal Society of New South Wales, 1882. Edited by A. Liversidge, F.R.S. Sydney: Thomas Richards. 1883.

This volume of the *Proceedings* of the Royal Society of New South Wales, the publication of which has been unavoidably delayed, contains a series of articles, sixteen in all, some of which are of an interesting character and indicate that the spirit of scientific enquiry exists in the colony. Now that this Society has been incorporated—in 1881—it is to be expected or at least hoped that the status that has thus been acquired will react with beneficial effect on its members, of which there is a considerable number, and that we shall soon learn of substantial investigations bearing on the many intricate problems concerning our fundamental ideas of matter, inorganised and organised, not only carried out by some of the members of the Society, but also published in these Transactions; investigations which, without that special character that may make them essentially of local interest, utilise the local opportunities towards the elucidation of the great scientific questions of the day. The publication of such work in the future volumes of the Society will, we trust, at a not far distant date, cause these volumes to be as well known and referred to as those of kindred scientific bodies.

Although the quantity of matter that is here produced is less than might be expected when all things are considered, the activity of several of the members who have the Society's reputation at heart must be acknowledged, and it is to be hoped that their efforts may stimulate many of the others to scientific enquiry.

In the anniversary address the President, Mr. H. C. Russell, confines himself to astronomical and meteorological matters, discussing the probable value of the parallax based on the results that have been obtained by the various methods of observation, and gives an account of the efforts that were being made in the colony, when the address was delivered, for the observation of the transit of Venus in 1882.

A considerable portion of this address is devoted to an interesting *resumé* of all the known facts relating to the "artificial" production of rain by large conflagrations, discharges of artillery, and such like, a subject which for the inhabitants of a pastoral or agricultural country favoured with too much sunshine is of much concern, certainly merits a full discussion, especially when we read that "so many proposals are put forward, some even going so far as to propose that our Government should take to cannonading the sky, it was time someone took the matter up." The aqueous vapour arising from a large conflagration producing rain is conceivable, but to "tom-tom" the sky with guns or other means in order to bring down rain would seem to be the height of absurdity.

The contributions to chemistry in this volume consist of descriptions with analyses, by Prof. Liversidge, of the Deniliquin and Bingera meteorites, together with two preliminary notices on the chemical composition of certain rocks from New Britain and New Ireland. Mr. W. A. Dixon gives several analyses of the ashes of certain epiphytic orchids. Geological science is represented by a series of papers by the Rev. J. E. Tenison Woods; that on the "Hawkesbury Sandstone," with the discussion that took place on its reading, which is added, being especially valuable. To the student of ethnology and sociology there are two papers in this collection that will be of some interest, relating to the customs of a race of beings rapidly becoming extinct, and of whom in a few years there will be little more left us than there is of the dodo. The notes on the Aborigines of New Holland, by Mr. James Manning, are particularly interesting, as they relate to the state of these people and their religious beliefs according to the writer's experience made forty years ago, before the race had lost all their native habits and became demoralised "between the missionaries and the rum." The article on the Aborigines of New South Wales, by Mr. J. Fraser, describes many of the ceremonial institutions, and is of much ethnological interest.

American Gems and Precious Stones. By George F. Kunz. Washington: Government Printing Office. 1883.

This small pamphlet contains short but interesting notes on the minerals found in the United States that are used for ornamental purposes, being an extract from "The Mineral Resources of the United States." The information here brought together is of a statistical character valuable to the dealer in precious stones and the lapidary, no attempt being made to describe these minerals in an abstruse way, or the parageneses of the different species.

The probability is great that the mineral veins of the United States will at some not far distant date yield a good supply of precious stones, although statistics relating to the present production are not of a very encouraging nature. It is difficult, if not impossible, to obtain accurate facts regarding the quantity of minerals found annually fit to be termed precious stones, but the author of this pamphlet, from an extensive correspondence with experts and dealers, estimates that the sales in 1882 of all gems of home production amounted to between fifty and sixty thousand dollars, the value of the stones before cutting being probably about ten thousand dollars, whereas for the same year the value of the precious stones imported into the country was over eight million dollars.

Although the geological structure of many districts in the United States would warrant a systematic search being made for precious stones, as yet, however, only at two places, Paris Maine and Stony Point, North Carolina, is mining for such minerals carried on; in many other cases the gems that are reported to have been found are either met with accidentally or found in mining for the commoner minerals. The sapphires, garnets, and olivines from Montana and New Mexico are gathered from the surface with little or no mining, the moss-agates from Colorado are picked up from the beds of the streams, and the specimens of chlorastrolite and thomsonite from Lake Superior are found on the beaches. The geological characteristics of North Carolina, as well as the garnet districts of Arizona and New Mexico, would seem, according to practical geologists, to hold out favourable prospects for the prosecution of diamond mining, but as yet only a few finds of this valuable gem are reported, as from Idaho, Cherokee Flat, San Francisco, and at the Portis Mine, North Carolina. The largest diamond yet known to have been found in the United States was picked up by a labourer engaged in grading one of the streets in Manchester, Chesterfield County, which weighed 10 carats after cutting. This specimen was sold by the finder for 1800 dollars, although its value was about three times this sum.

The sapphires and rubies found at Vernon, New Jersey, are always more or less opaque, and although some specimens have been cut their want of transparency does not entitle them to the term of gems. Better finds are reported to have been made at the Corundum Mines, North Carolina, the stones here met with being of high class colour but small, a few weighing about 2 carats; the highest value of any single gem probably not exceeding 100 dollars. In the garnet districts of Montana, Santa

Fé, Southern Colorado, and Arizona, rubies and sapphires occur in the sand associated with peridote, pyrope, and almandine garnet; occasionally, too, this gem stone is found on ant-hills, which abound in the last named district. The gems are usually of a pale green, greenish blue, or light red tint, and are dichroic, perfect stones weighing from four to six carats being frequently found.

A few fine specimens of spinel are reported from San Luis Obispo, California, weighing about 2 carats each. Topazes, suitable for ornamental purposes, have been picked up in Arizona, New Mexico, and occasionally in Southern Colorado. More recently crystals have been found at Pike's Peak, Colorado, and at Stoneham, Maine. Many of the specimens are of a pale blue tint, and might be cut into gems; the supply, however, is very small, probably not more than 100 dollars yearly.

The beryl gems are found in many parts of the States, often in crystals of large dimensions, but specimens of a good colour are comparatively rare, the finest, of a rich blue tint, occurring at Royalston, Massachusetts. The supply of these gems is not great, the entire amount for the last ten years, the author states, would not exceed 2000 dollars. Crystals of phenakite have been found at Pike's Peak, Colorado, some of them of remarkable clearness and equal in size to the specimens from Siberia. Zircons, although found in some abundance in North Carolina, are for the most part too imperfect in colour and size to be of much value as gems. Hiddenite or "lithia emerald," a new and strictly American mineral, is found associated with beryl, rutile, and garnet; stones weighing up to 2½ carats and of good colour have been discovered. This mineral, the demand for which at present exceeds the supply, forms with tourmaline the only precious stones that are actively mined for in the United States.

Large numbers of very fine perfect crystals of quartz are found embedded in the calcareous sandstone in Herkimer County at Lake George, and in New York State, and form an item of some commercial value in these districts, being sold to tourists as "Lake George Diamonds." In Arkansas, at Crystal Mountain, and the district round the Hot Springs, the trade in quartz crystals is also considerable; this mineral being collected by the farmers by the waggon load, "who often do blasting to secure the crystals, looking for them at such times as their crops need no attention. In the course of a year possibly 100 loads are sold, principally as mementos, to the visitors at these resorts."

Regarding the occurrence of turquois in New Mexico the author gives a short account of the localities where this mineral has been found, quoted from two observers who have been over the country. Although there is evidence to show that this mineral has been prized by the Indians, and that mining operations have been conducted for a long time, the mines being known to have been well developed in 1680, yet at present the output is very small; the material cut and sold as gems not being more than 1500 dollars per annum, the specimens being sold merely as oddities.

To this short pamphlet Mr. Kunz appends a list of gem stones known to occur in the United States, and of a few that are known only to have been found in the country.

CORRESPONDENCE.

IRON IN CHLOROPHYLL.

To the Editor of the Chemical News.

Sir,—Dr. A. B. Griffiths seems to have misread Dr. Schunck's paper on chlorophyll in the *Proceedings of the Royal Society*, and has tested for iron in the residue instead of in the solution obtained by boiling leaves in alcohol. He also does not appear to have seen Dr. Schunck's supplementary note in the same number of the *Proceedings*, in which he shows that chlorophyll is not a glucoside.

The possible existence of iron in chlorophyll seemed a matter of such importance that during this week I have had some of the ethereal solution prepared from spinach according to Dr. Schunck's directions, and which therefore contained the glucoside in addition to the chlorophyll. The solution was evaporated, and a quarter of a decigrm. of the residue placed on platinum foil, ignited, a small piece of nitre added to burn off the last traces of carbon and to oxidise the iron. The foil was then boiled in concentrated hydrochloric acid, the solution evaporated to dryness to expel the excess of iron, and the residue dissolved in water and tested with potassic ferrocyanide and potassic sulphocyanate. In both cases there was only the very slightest indication of iron. In another experiment, in which the acid was not evaporated off, no colour was produced by the ferrocyanide, although about half a decigramme of the chlorophyll residue was used.

It may be useful to state that the spinach was grown in the College garden, and that the soil in this neighbourhood contains an appreciable quantity of iron, the water from an old pump, now disused, coming up inky when a new leather bucket had been put to the piston.—I am, &c.,

Herbert McLeod.

Cooper's Hill, June 7, 1884.

EFFECTS OF SULPHUR AND CHLORINE ON PLANTS.

To the Editor of the Chemical News.

Sir,—A letter appeared in your columns recently (p. 229), signed by "F. J. Lloyd," in reference to the injurious effects which have been found to follow the use of sulphur and chlorine in manures (notably in superphosphate and in sulphate and muriate of potash). I think it well to say, for the benefit of those who may not be so familiar with the subject as to discern it for themselves, that there is nothing in that letter explanatory of the results nor worthy of being noticed in detail.—I am, &c.,

T. Jamieson,
Lecturer on Agriculture,
University of Aberdeen.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 17, April 28, 1884.

Absolute Standard of Light.—J. Violle.—The author takes as his absolute unit the radiation emitted by a square centimetre of platinum at its point of solidification, the intensity of which is about equal to 11 Carcel lamps.

Determination of the Ohm.—E. Mascart, F. de Nerville, and R. Benoit.—The authors conclude that the value of the ohm is represented by a column of mercury at 0° of 1 square millimetre in section and 1063·3 millimetres in length.

Apparent Resistance of the Voltaic Arc in Lighthouses.—F. Lucas.—With an intensity of 50 ampères, and a distance of 0·004 metre between the points of the Carré carbons,—which are the normal conditions for the production of the voltaic arc in lighthouses—the resistance of the arc is 0·58 ohm.

Telluric Currents.—E. C. Blavier.—The variations of terrestrial magnetism, whether regular or accidental, are

due to electric currents which circulate in the atmosphere at a greater or less distance from the ground, and the circuit of which is completed either directly when they encircle the entire globe or by the intervention of the earth, but at a depth sufficiently great to have no action upon the magnetic needle.

Application of the Laws of Induction to the Helio-electric Theory of the Perturbations of Terrestrial Magnetism.—M. Quet.—When the solar currents vary suddenly in intensity, the resulting force of induction must seize simultaneously all the parts of the electric fluid of the earth, and the magnetic perturbations which result must commence simultaneously on all points of the globe.

Direct Determination of the Order of the Cause of the Deficiency in Electro-dynamic Machines.—G. Cabanellas.—This paper does not admit of useful abstraction.

Congelation-point of Solutions of the Salts of the Diatomic Metals.—F. M. Raoult.—All the neutral salts resulting from the action of monobasic acids upon the oxides of the biatomic alkaline-earthy and earthy metals produce a molecular depression of the coagulation-point comprised between 41 and 48, with a mean of 45. All neutral salts resulting from the action of the bibasic acids upon the same oxides produce a molecular depression of congelation included between 18 and 22, with a mean of 20. Whenever in the molecule of a salt of a monobasic or bibasic acid, supposed to be dissolved in 100 grms. of water, 1 atom of diatomic alkaline-earthy or earthy metal is replaced by an equivalent quantity (*i.e.*, two atoms) of a mono-atomic metal, the depression of the congelation-point increases by a quantity which is almost constant. Double decompositions which may take place without the formation of a precipitate among neutral salts of the diatomic alkaline, alkaline-earthy, or earthy metals, with monobasic or bibasic acids produce in the congelation-point of the mixture either a very feeble change or none at all.

Formation of Amides by setting out from the Ammoniacal Salts of the Organic Acids.—N. Menschutkin.—The amides are formed at temperatures higher than 100° with a speed which increases with the temperature, and after a time a limit is reached. The general march of the reaction and its graphic representation at various temperatures are completely analogous to the formation of compound ethers in the reaction of the acids on the alcohols.

A Glucoside of Boldoa fragrans.—P. Chapoteaut.—This plant contains a feebly alkaline principle, *boldine*, and a glucoside $\text{Ɵ}_{39}H_{52}O_8$. If heated with dilute hydrochloric acid it is split up into glucose, methyl chloride, and a syrupy compound soluble in alcohol and benzol, but insoluble in water.

Researches on Hydraulicity: Influence of Heating and Carbonic Acid upon the Setting of Siliceous Cements.—E. Landrin.—This memoir does not admit of useful abstraction.

Existence of Manganese in Wines and in a Number of Vegetable or Animal Productions.—E. J. Maumené.—Manganese appears to exist in all wines, but its presence is purely accidental, and its quantity is too small to have any effect. In the cereals it is present to a much greater extent. The author thinks that it possibly plays a more important part in the life of animals than does iron.

Assimilability of Phosphoric Acid contained in the Rocks and in Arable Soils.—G. Lechartier.—The author shows that phosphoric acid as it exists in the chief rocks of Bretagne can be directly assimilated by plants. If phosphoric acid has been extracted from rocks, &c., by means of ammonium oxalate, it cannot be precipitated from the solution by means of molybdic mixture. The solution must first be evaporated down, the salt decomposed by heat, and the phosphoric acid separated from the ferruginous residue obtained.

Researches on Respiratory Combustion.—P. Schützenberger.—Not adapted for abstraction.

No. 18, May 5, 1884.

This number contains no memoirs, being taken up with the awards of the various prizes which the Academy has to confer.

Moniteur Scientifique, Quesneville.
Vol. xiv., April, 1884.

Patents and Certificates of Addition taken in France during the year 1884.—The nature of this article appears sufficiently from its title.

Patents concerning Colouring-Matters issued in Berlin during January and February, 1884.—A list of specifications not capable of useful abstraction.

Modern Processes for Dyeing: Recent Improvements in Fixing Colouring-Matters upon the Fibre.—Dr. Riemann.—The author defends the use of antimony—tartar emetic—in mordanting cottons to be dyed in aniline colours. He insists on the importance of abandoning the original method of dyeing silks and woollens in anilines without any mordant, and recommends, in case of woollens, the addition to the dye-beck of zinc sulphate, the goods being afterwards taken through soap-lye or through a solution of soda crystals. Shades got up in this manner bear not merely soaping, but in many cases even fulling. He points out that eosine and its kindred, unlike the original coal-tar colours, have a radicle which is not basic, but acid. The eosines, in spite of their beauty, have but a limited application, on account of their inability to resist the action of light. In like manner the azo-reds cannot be used as substitutes for cochineal in dyeing army-cloths. Lac-dye, though much employed thirty to forty years ago, is now known to the majority of dyers merely by name. (We can attest that sixteen years ago it was abundantly used in Yorkshire.) Safflower, Dr. Reimann further asserts, has been displaced by saffranine and by madder, which in turn have given place to artificial alizarin. (It may surely be questioned whether either natural or artificial alizarin can produce pinks and roses equal in purity and lustre to the safflower shades.)

The Colours employed in Calico-printing, and the Means used for their Fixation.—Robert Bourcart.—This memoir is an account of the methods commonly used in England, and is not susceptible of useful abstraction.

Contribution to the Chemistry of Mordants.—MM. Liecht and Suida.—From the *Journal of the Society of Chemical Industry*.

On Chemical Manures.—Dr. Cohn.—A summary of the known sources of ammonia, potash, and phosphoric acid, and of the means of rendering the latter available.

Industrial Society of Mulhouse.—Meeting of the Chemical Section, February 13th, 1884.—The President read a communication, by MM. Depierre and Clouet, on the action of the electric light, and of solar light upon colours printed on cotton. They conclude that the electric light bleaches colouring-matters: the coloured rays both of sunlight and of the electric light are efficacious, though in different degrees. The action of light, solar or electric, is recognised whether the colours are exposed to or protected from the air. The order of action of the rays increases in the following order:—Yellow, blue, green, orange, violet, red.

M. A. Haller, of Nancy, sent in a memoir on cyanomalonic acid and its derivatives.

M. Goppelsrœder sent in a memoir on the reduction of indigo by electrolytic hydrogen.

M. Nœlting described certain researches undertaken in concert with M. Binder, on the transformation of the diazoamido derivatives into amido-azo compounds.

Review of Chemical Researches published Abroad.—A series of abstracts from the *Berichte der Deutsch. Chem. Gesell.*, and from *Liebig's Annalen.*

On Vaseline.—J. Otto.—An account of the preparation and pharmaceutical uses of this body. Its valuable properties have been much exaggerated. In contact with air and light it is decidedly capable of becoming rancid.

Liquid Carbonic Acid under a Regular Pressure.—A. Zimmermann.—From the *Journal of the Society of Chemical Industry.*

Archives Neerlandaises des Sciences Exactes et Naturelles.
Tome xviii., Part 5.

Hæmatoxylin as a Special Reagent for Cellulosic Membranes, neither Lignified nor Suberified.—E. Giltay.—The author prepares this reagent by taking 5 c.c. of a solution (kept in reserve) of 7 grms. hæmatoxylin in 50 c.c. of water, and adding these 5 c.c. to 100 c.c. of a solution of alum at $\frac{3}{4}$ per cent. It is well to prepare this mixture a couple of days before using it, and to filter a small quantity each time. For use the liquid is poured into a glass in a shallow stratum, not more than $\frac{1}{2}$ c.m. at most, the section of tissue is introduced into the liquid, and the glass is held above a small mirror, inclined so that the light may be thrown through the reagent. Cellulose, if present, is coloured blue, whilst lignified or suberified tissues are not acted on.

Cosmos les Mondes.
No. 14, April 5, 1884.

Gas from Farmyard Manure.—It is said that the gases given off during the fermentation of dung in a closed vessel consist so largely of hydrocarbons that they may be used for lighting purposes. M. Gayon is said to have exhibited this light at Bordeaux.

No. 15, April 12, 1884.

Glue for Rendering Paper Waterproof.—Labels may be fixed upon tin boxes, &c., exposed to damp by the following method. White of egg is diluted with one half part of water and applied with a brush to the surfaces to be united. A hot iron is then passed over the paper, so as to coagulate the albumen. By means of successive layers of paper and albumen, waterproof boxes, &c., may be formed.

Combination-Heats of the Compounds of Sodium.—Dr. T. Tommasi.—A table of the combination-heats of sodium salts, as calculated and determined experimentally.

The Radiguet Constant Battery.—This paper requires the four accompanying illustrations.

A New Source of Electricity.—J. A. Kendall.—From the *Proceedings of the Royal Society.*

No. 16, April 19, 1884.

M. Honigmann, of Aix-la-Chapelle, propels a locomotive without fire and without coal by means of caustic soda.

The *Journal d'Hygèine* ascribes great antiseptic and germicide power to free citric acid.

In the town of Utrecht, which is supplied with an exceedingly pure water, it has been found necessary to make use of tin service-pipes coated externally with lead.

Professor Landolt has recently exhibited to the Berlin Academy of Sciences a cylinder of solidified carbonic acid which he kept for more than an hour in that state. He had passed the current of liquefied carbonic acid from a compressor into a conical bag, in which it resembled melting snow. It was then pressed in a cylindrical mould by means of a rammer.

No. 17, April 26, 1884.

This issue contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Separation of Tartaric and Phosphoric Acids.—I have a mixture of acid phosphate of lime and tartarate of lime, with an excess of sulphuric acid, all in solution, and require to determine the sulphuric, phosphoric, and tartaric acids. Can any of your readers supply a good method for the quantitative separation of tartaric and phosphoric acids?—W. M. Allan.

MEETINGS FOR THE WEEK.

Saturday, 14.—Physical, 3. "On the Velocity of Sound in Tubes," by D. J. Blaikley. "On a New Apparatus for Colour Combinations," by H. H. Hoffert.
Wednesday, 18th.—Meteorological, 7.
Thursday, 19th.—Royal, 4.30.
— Royal Society Club, 6.30. (Anniversary).
— Philosophical Club, 6·30.
— Chemical, 8. "On the Magnetic Rotation of Chemical Bodies in relation to their Composition and Constitution," by Dr. Perkin; "On the Effect of High Temperatures on Petroleum Hydrocarbons," by Drs. Armstrong and Miller; "On Nitrification" (Part III.)," by R. Warington.

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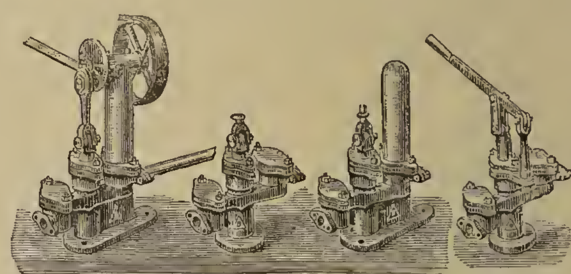

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1282.

THE PHYSICAL AND CHEMICAL ANALYSIS OF FLOUR.*

By ALBERT R. LEEDS.

THE great attention paid during five years past in the United States to the subject of the adulteration of foods has already resulted in a voluminous literature. Unfortunately, much of this literature is crude and erroneous, and especially that referring to the topic of the present article. Originally appearing with specious pretences of scientific merit in certain medical journals, these misstatements have gained credence with many reputable medical practitioners. Finally, having permeated downward into the columns of the daily press and into the popular mind, they have become so firmly lodged as to make their eradication difficult.

Foremost in this direction was a paper published in Gaillard's *Medical Journal*, January, 1882, with the following alarming title:—"Highly important and extensively advertised cereal foods under the microscope. The genuine, the spurious, the worthless, and the fraudulent. Therapeutic as well as dietetic facts of great value to physicians and their patients. By Ephraim Cutter, A.M., M.D., Harvard, &c." The only means of research employed by the author of this paper was the microscope, which he styles an "unerring teacher," "an infallible detector of fraudulent claims in regard to cereal foods," &c. The results of microscopic examinations are termed analyses, and as such are expressed in *figures denoting the relative percentages of gluten and starch*. The principal feature of the article, and the one most calculated to awe and convince the popular mind, was the woodcuts with which it was profusely illustrated, and which purported to be impartial representations of what might be seen of these foods when looked at through an objective, magnifying 800 diameters. Some of these cuts or slides represent flour entirely made up of unruptured gluten cells, while specimens of other flour, quite as remarkable, but for a different reason, are represented as composed of starch cells and fibrous tissue only. The two flours which are more especially singled out, the one for unstinted praise, the other for condemnation, are the Franklin Mills Entire Wheat Flour, and the Gluten Flour of the New York Health Food Co. Besides the woodcuts which represent the former as composed almost entirely of gluten cells, the excellence of the former flour incites the microscopist to add that, "So long as the makers maintain such a proportion of gluten cells, they confer a blessing on mankind." On the other hand, the gluten flour is stigmatised as "a meal and not a flour. The circulars are travesties, and show an ignorance which, if it did not affect human life, would be ridiculous. In all this so-called gluten flour which the microscopist examined, he states that in repeated examinations only seventy gluten cells were found.

Chemical analyses show the falsity of these statements, as I will explain later on. But even without the aid of positive knowledge, founded on analytical data, these statements should have deceived no one accustomed to the use of the microscope, as is evident from the following considerations:—In the first place, in making a chemical analysis of flour, as much as 10 grms. should be used. The analysis of so large a quantity affords a guarantee that the figures obtained represent the average composition of a mechanical mixture of the constituents of a non-homogeneous product like flour. But the weight of flour exhibited on a microscopic slide does not exceed the 1-100,000th part of the quantity taken for chemical analysis, and could not fairly represent an average. Neither can one determine by counting upon one slide or upon a hundred slides, the relative number of starch cells and *unruptured* gluten cells, what is the percentage of starch and gluten. It could not be done even were the gluten cells unruptured. But in the process of grinding they are largely broken and their contents commingled with the starch. When so commingled, it is difficult even with the aid of chemical reagents to discriminate between the albumenoid and amyloid constituents of flour. To estimate their percentage amounts by counting is impossible.

So different in appearance are the various parts of one slide, and so different are various slides prepared from one and the same flour, that the use of pictures of such slides to substantiate statements as to differences in composition in the flours examined, is misleading. Lest any microscopist should regard this protest as unnecessary, since it is but insisting upon a matter with which he is already familiar, let him call to mind how successfully the public is deceived by the claim that microscopic research necessarily implies research of great scientific exactitude. In the present instance certainly, authorities in medical science were led astray. Had they but reflected for a moment that Dr. Cutter's assertion, that many of the cereal foods examined contained no gluten whatsoever, was in itself a sufficient proof of the falsity of his statements, insomuch that there is no flour but what necessarily contains some gluten, they would not have indorsed his publications without independent examinations. But in an address delivered before the New York Medical Society, February 8th, 1882, its President, Dr. A. Jacobi, says of these microscopic examinations of Dr. Cutter: "I shall refer to his statements, desiring to give them the greatest possible publicity. I wish the brief article of his would be distributed in a hundred thousand copies, reprinted in every secular paper, read from every platform and pulpit of the land. For it is time that fraud should be stopped, and a nefarious trade suppressed."

Then follows a *résumé* of Dr. Cutter's labours, in which without any assurance on the part of the presiding officer of a distinguished medical society, that he has submitted statements involving the reputation and business fortunes of more than two-score of the manufacturers of cereal foods in the United States to any independent critical research, he bestows indiscriminate and exaggerated commendation upon them all.

In a paper published in the *Transactions of the College of Physicians of Philadelphia*, 3rd series, vi., 377, I have given the results of the examinations of many of the foods referred to, the examinations being conducted with the aid of the microscope and mechanical manipulations, but controlled by chemical analysis. Without quoting in detail, I shall insert in this place only the table of analyses as showing how incorrect was the statement made by Dr. Cutter and approved by Dr. Jacobi, of the absence of gluten in Blair's Wheat Food, "Imperial Granum, Ridge's Food, Savory and Moore's Food, Farwell and Rhine's Gluten Flour, Hubbell's Prepared Wheat," and other cereal preparations.

The microscopic drawings alluded to were made, it is stated, by Dr. A. T. Cuzner. Recently, in what purported to be a summary of certain information contained in a book entitled "What we Eat and What we Drink," this gentleman has published, under the title of "Food Analyses—Flour," a paper in the *Scientific American*, Supplement, No. 414, in which statements are made similar to those advanced by Dr. Cutter, but nominally supported by proofs of quite different character. The fact that the microscope gives incorrect notions of the relative amounts of gluten and starch is admitted, and the attempt to make a quantitative analysis of flour by the use of this instrument

* Advance sheets communicated by the author. Reprinted from the *Journal of the American Chemical Society*, vol. vi., No. 3.

Analyses of Health and Infant Foods.

Food Analysed.	Water.	Fat.	Grape Sugar.	Cane Sugar.	Starch.	Soluble Carbo-hydrts.	Albu-mnds.	Gum, Cellulose, &c.	Insol. Resi-due.	Total.	Reaction.
Baby Sup, No. 1	5·54	1·28	2·20	11·70	61·99	14·35	9·75	7·09	—	100·00	Neutral
Baby Sup, No. 2	11·48	0·62	2·44	2·48	51·95	22·79	7·92	5·24	—	100·00	Slightly alkaline
Gerber & Co.'s Milk Food .	6·78	2·21	6·06	30·50	38·48	44·76	9·56	—	—	101·79	Slightly acid
Ridge's Food for Infants..	9·23	0·63	2·40	2·20	77·96	5·19	9·24	—	—	102·25	Neutral
Victor Baby Food	7·49	1·62	0·62	19·92	63·45	20·54	8·87	—	—	101·97	Slightly acid
Anglo-Swiss Milk Food ..	6·54	2·72	23·29	21·40	34·55	46·43	10·26	—	—	100·50	Slightly acid
Horlick's Food for Infants.	3·39	0·08	34·99	12·45	none	87·20	6·71	—	2·62	100·00	Slightly acid
K. and M.'s Infants' Food.	27·95	—	36·75	7·58	none	71·50	none	—	0·55	100·00	Neutral
Nestle's Milk Food	4·72	1·91	6·02	32·93	40·16	44·88	8·23	—	0·08	100·00	Slightly alkaline
Hawley's Liebig's Food ..	6·60	0·61	40·57	3·44	10·97	76·54	5·38	—	—	100·10	Slightly acid
Hazard's Graham Farina..	9·12	0·81	2·19	2·49	69·68	6·35	8·48	5·56	—	100·00	Neutral
Cereal Milk..	9·33	1·01	4·60	15·40	58·42	20·00	11·08	—	—	100·16	Slightly acid
Mellin's Food	5·00	0·15	44·69	3·51	none	85·44	5·95	—	3·46	100·00	Slightly alkaline
Blair's Prepared Wheat Food	9·85	1·56	1·75	1·71	64·80	13·69	7·16	2·94	—	100·00	Neutral
Savory & Moore's Infts. Food	8·34	0·40	20·41	9·08	36·36	44·83	9·63	0·44	—	100·00	Neutral
Hubbell's Preprd. Wheat Fd.	7·78	0·41	7·56	4·87	67·60	14·29	10·13	undet.	—	100·21	Neutral
American-Swiss Milk Prdct. Co.	5·68	6·81	5·78	36·43	30·85	45·35	10·54	0·77	—	100·00	Acid
Wheat Flour for Hubbel's Wheat Food..	9·02	1·01	2·34	2·46	76·07	5·66	6·40	—	—	—	Neutral
Imperial Granum..	5·49	1·01	trace	trace	78·93	3·56	10·51	0·50	—	100·00	Neutral
Robinson's Patent Barley ..	10·10	0·97	3·08	0·90	77·76	4·11	5·13	1·93	—	100·00	Neutral
Farwell and Rhine's Gluten Flour	12·67	0·84	2·23	1·42	68·36	7·23	10·39	0·51	—	100·00	Neutral

is abandoned. At the same time the pictures of flour as seen under the microscope are quite different from flour as it actually appears when thus examined.

In the accompanying reproduction of the drawing made by Dr. Cuzner, No. I. fig., and purporting to be a micrograph of the Pillsbury best flour, the large circles with rays or crosses at their centres, and marked A, are stated to be pictures of giant starch cells; B to stand for smaller starch cells, and C for granular gluten. Whether C is a mere dot, or a very small circle without a dot in its centre, is not clear from the drawing. But that the smaller starch cells are circles with dots in their centres appears to have been certainly intended.

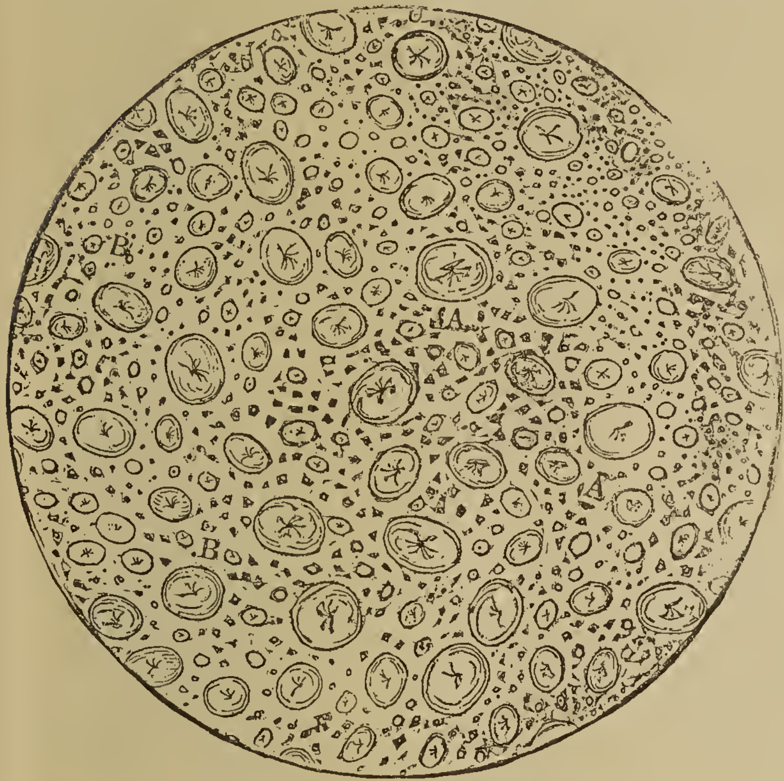
This drawing presumably represents the appearance in ordinary light, but in that light starch granules do not exhibit crosses, nor in any light crosses of the character depicted in the drawing. Moreover, gluten cannot be distinguished from starch in the manner stated.

The next photo-engraving, No. II., is a reproduction which (to quote the language of the original article) "represents the appearance of the Franklin Mills flour, and equally well represents the Health Food Company's flour, with the exception that in this flour is seen a *much larger proportion* of the bran coat with gluten cells attached, as well as unattached, together with some *hairs of wheat*, than is found in the Franklin Mills flour. In the figure, A, are seen giant starch cells; B, portion of bran coat; C, portion of bran coat with gluten cells unruptured."

The microscopist will be struck by the remarkable fact that this cut, which is entitled "Health food gluten flour as seen under the microscope," represents a number of thin sections of the wheat-berry. Most of these sections are transverse, and represent very beautifully the epicarp, endocarp, testa, and secundine of the berry, precisely as they appear when viewed in their natural positions to one another. The largest section is a diagram illustrating the relative position of the three outer coats of the berry as viewed from without. It is a matter of nicety to prepare such excellent sections of the berry, when it is sliced with a knife, and in the crushed fragments of the berry that remain after it has been ground into flour I had never seen anything of the character above figured. But, thinking other observers might have been more fortunate, I looked through the literature of the subject, and found precisely the same diagrams as those figured by Dr. Cuzner. In the latter case they appear in company with giant starch cells (granules?), whose magnitude is comparable with the unruptured gluten cells. In the former they appear as illustrations of thin sections of the berry, Fig. 3 in the above cut No. III., showing "the relative position of the several layers of the investing coats of the berry, as seen from without; Fig. 4, as viewed in a section transverse to the greater length of the berry; Fig. 5, as presented in longitudinal section." In the latter case, as reproduced by Dr. Cuzner, they are portions of what he saw when Health Food gluten flour was examined under the microscope; in the former they form the cut which can be found on page 4, "Report on Vienna Bread," printed in 1875 at the Government Printing-Office in Washington, this Report having been written by E. N. Horsford, U. S. Commissioner to the Vienna International Exhibition, 1873. I have had this last cut, No. III., reproduced by photo-engraving to compare with Dr. Cuzner's No. II.

It is needless further to insist upon the worthlessness of mere microscopic inspection in determining the relative composition of flour. But after the erroneous nature of the results arrived at by Dr. Cutter by means of microscopic inspection only had been pointed out, one of his critics, Prof. J. G. Richardson, in an article entitled "A Serious Microscopic Blunder" (*Phila. Med. News*, June, 1882), called attention to the fact that he or any other physician, without the employment of the more exact methods of chemical analysis, could obtain sufficiently approximate results by simple manipulation of flour to prevent them from being led astray in the matter. He says:—"Dr. Cutter asserts that the opaque, oval, or rounded cells (constituting the fourth coat of the wheat grain, according to Prof. Parkes) afford most of the gluten, and hence on their presence the chief strength of the food depends." He therefore declares that a large number (fourteen) of the food-stuffs he examined, and found under his microscope to display none of these so-called "gluten-cells," "contain no gluten" (page 9), and broadly intimates that they are consequently frauds upon the public. But the fact is, these so-called "gluten-cells" (denominated by Payen *oleiferes*) probably include in their substance starch, phosphates, fatty matters, and colouring materials, containing only parts, perhaps but a small part, less than one-seventh, of the gluten which exists in wheat. Thus Peligot, as a mean of fourteen analyses, gives the percentage of gluten in flour (whence "gluten-cells" are removed) at 12·8, while in bran (containing nearly all the "gluten-cells") it is only 10·84, and other observers confirm his statements. If my friend Dr. Cutter, or any of his disciples, would like to satisfy himself that he has made a lamentable mistake in this matter, let him take

say 10 grms. of one of the fine flours he asserts "contain no gluten," mix it with water into a dough, let it stand for half an hour, and then stir it in a porcelain capsule, with successive portions of water, until the starch is washed away, and the adhesive fibrillated gluten is left nearly pure, in the proportion, after drying, of from 7 to 12 per cent. (*Vide* Parkes's "Practical Hygiene," fifth edition, 1878, p. 224). The small starch corpuscles and granules, left by this process entangled among the threads of gluten, can be beautifully differentiated by adding a drop of iodine solution, which affords the usual deep blue reaction with the starch, but dyes the gluten filaments of a yellowish brown tint.



No. I.

No. II.

Fig. 3.

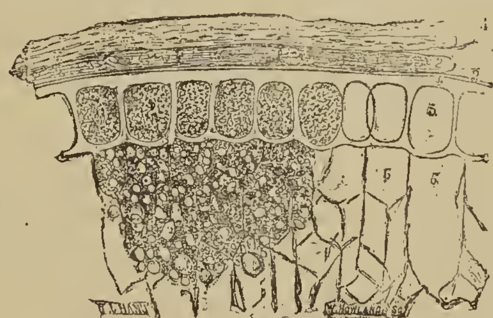


Fig. 4.

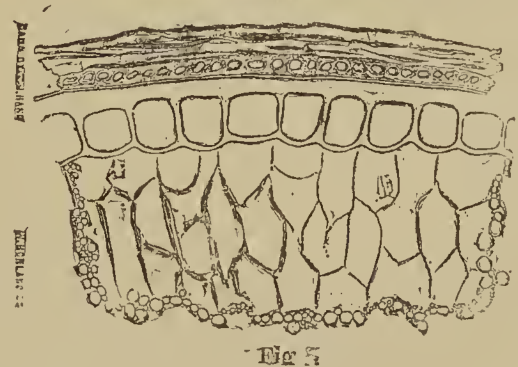


Fig. 5

No. III.

The chemist will recognise, in the above extract from Parkes's "Hygiene," the result of the investigations of v. Bibra, Millon, Rivot, Ritthausen, and others upon the gluten contained in cereals. The method elaborated by these chemists appears to have been adopted after the above suggestions. by Dr. Cuzner, but unfortunately with a modification which robs it at the same time of its simplicity and its value. For instead of manipulating the gluten-dough in a very small flow of water directly between the fingers (which is best), Dr. Cuzner proposes to tie it up in a muslin bag, and manipulate this in a jar of water until all the starch is washed out.

His language is—"Having an occasion to make an analysis of certain flours as to the relative amount of starch and gluten they each contained, I thought that the process adopted, being simple, and one easily carried out by persons of ordinary intelligence, it would interest your readers and give them the means of ascertaining for themselves the food value of any flour they might at any time be using as food in their families."

Then follows more in detail the process, which is as

follows :—" A certain portion (2000 grs.) of each of these flours was mixed with water, separately from the rest, and inclosed in a piece of muslin, as we inclose a pudding. This inclosed dough was then kneaded in a certain amount of water in order to separate the starch from the rest of the flour. During this kneading process water readily passed through the cloth to the dough, and back again to the remainder of the water, carrying with it on its return the starch cells, albumen, and sugar. By continuing this kneading process the starch, sugar, albumen, and gum were finally separated from the gluten, which remained a soft, tenacious, elastic substance, insoluble in water, inside the cloth. The gluten was then removed from the inside of the cloth, moulded, dried, and weighed. The water containing the starch, gum, albumen, and sugar was placed in a vessel and allowed to stand for some hours, in order that time might be allowed for the starch cells to settle to the bottom.

" At the end of this time the water was poured off, and the starch moulded into a cake, dried, and weighed. In the examination of the Franklin Mills and Health Food Company's flour an additional process was required. During the kneading process, described above, the fine bran with adherent gluten cells was forced through the cloth and became mixed with the starch cells in the water. This water had to be filtered through very fine lawn muslin. The starch cells readily passed through this cloth, but the bran was detained on the muslin, and afterward collected, dried, and weighed. As the purpose of this analysis was not to ascertain the amount of albumen, gum, and sugar contained in the flours, but rather the amount of gluten and starch, the examination was continued no further. But if the reader should desire to ascertain how much albumen, gum, and sugar a certain amount of flour contains, the following process may be adopted :—Take the water poured off from the settled starch, and boil it. This will coagulate the contained albumen, which can be collected on a filter, dried, and weighed. The water that passes through the filter can afterwards be evaporated over boiling water, and the gum and sugar collected, dried, and weighed."

An entirely original and quite surprising use of pictorial illustration in connection with analysis is now given. Three rectangular blocks are depicted with sharp angles and perfectly plane sides as representing the dried gluten obtained from the three flours. They are all equally symmetrical, and distinguishable only by the fact that the Franklin Mills gluten cake is large, the Health Food Company's gluten small, and the Pillsbury gluten cake of intermediate size. The striking angularity and symmetry of these gluten blocks, which appear as if cut out of steel, is puzzling. Crude gluten, as I have encountered it, is an extremely tough substance, of a leather-like consistency, which, on drying, is puffed out by the imprisoned moisture in globular and more or less fantastic shapes.

Three equally symmetrical blocks, also in all respects similar, except in size, represent the starch. They have a monumental character, and more closely represent gravestones than anything in the nature of starch. Difficult as the task would be of moulding crude gluten into rectangular blocks, yet it would be easy of execution compared with that of compacting starch granules into similar masses,—an achievement thus far to me quite inexplicable. Two more solid blocks represent bran ; that from the Franklin Mills flour small, that from the Health Food Co. large. How bran which has been separated from both starch and gluten can be built up, compacted, dried, and weighed in coherent rectangular blocks is not explained.

The author then gives his results, which I have reduced to per cents, and supplemented with the percentages unaccounted for.

	Bran. Per ct.	Gluten. Per ct.	Starch. Per ct.	Unaccounted for. Per ct.
Pillsbury best flour ..	—	13·25	80	6·75
Franklin Mills flour ..	2·5	15·75	50	31·75
Health Food Co. flour	7·5	7·00	45	41·5

The absurdity of styling that an analysis in which 30 to 40 per cent of the constituents of the flour are to be put down as albumen, gum, sugar, moisture, salts, &c., is manifest.

The process was then tried on some " Pillsbury best " flour and some Health Food Co.'s whole wheat flour: 150 grms. of each flour were taken, made into a dough, and inclosed in pieces of muslin cloth. These pieces of muslin cloth were previously washed, dried, and weighed. They were then kneaded in water until the washings were no longer milky, an operation requiring many hours, when the wash-waters—amounting in one case to 8, in the other to 10 litres—were collected and allowed to stand. At the end of a week the precipitation of starch was still incomplete, the supernatant liquid appearing milky. The liquid was then syphoned off, great care being requisite to prevent disturbance in the easily moved starch granules at the bottom. How to get rid of the last portions of water without losing some of the starch, and, in case this were successfully accomplished, how the starch could be detached from the vessels and moulded into cakes without loss,—these difficulties I saw no way of overcoming. Instead the starch was filtered off upon tared filters, and after drying at 110° in the ordinary manner was weighed.

The gluten was detached, as far as was practicable, from the muslin cloth, and, after drying the latter, the weight of the gluten which could not be detached was added to the weight of the main portion after drying at 110°. Great care must be exercised to obtain constant weights on drying, owing to the slowness with which the gluten gives up its last portions of moisture. If so many hours and such large amounts of water were requisite to wash the starch through ordinary muslin, the further separation of all this starch from bran by passing it a second time in a state of suspension in water through very fine lawn muslin, appeared impracticable.

The total soluble matter in the filtrates from the starch was determined, and also the crude gluten in the same. This was necessary, inasmuch as some of the gluten remained behind, and some passed through the muslin. Microscopic examination showed that the so-called starch contained cellular tissue and gluten, the so-called gluten contained cellulose and starch. Weighings performed on impure products of this kind of course have no real value

Physical Analyses by Washing in Bags.

	Pillsbury Best.	Health Food Flour
Starch	69·25 per cent.	52·92 per cent.
Gluten remaining in bag	3·40 ,,	21·41 ,,
Gluten in wash-waters	8·56 ,,	5·94 ,,
Soluble matters in wash-water..	4·94 ,,	4·96 ,,
Water in flour	11·10 ,,	11·32 ,,
Total found	97·25 ,,	96·55 ,,
Unaccounted for ..	2·75 ,,	3·45 ,,

Chemical Analysis of same Specimens of Flour.

	Pillsbury Best.	Health Food Flour.
Starch	67·86 per cent.	65·19 per cent.
Soluble albumen.. ..	2·84 ,,	2·30 ,,
Insoluble albumen ..	8·62 ,,	11·21 ,,
Total albumen	11·45 ,,	13·51 ,,
Sugar	2·83 ,,	2·67 ,,
Gum	5·02 ,,	3·84 ,,
Fat	1·31 ,,	1·63 ,,
Cellulose	0·81 ,,	2·35 ,,
Saline, &c.	0·42 ,,	1·38 ,,
Phosphoric acid	0·17 ,,	0·39 ,,
Water	11·10 ,,	11·32 ,,
Total..	100·81	101·89

The result of the latter analysis coming out differently from what I anticipated, former analyses having shown that the Health Food Flour contained much the largest

amount of albumenoids of any of the many samples of flour analysed, determinations were made of two more samples of the same flour. They agree better with the former figures, although still falling short in percentage of albumenoids of the results obtained on other samples.

	Lab. No. 1129.	Lab. No. 1130.
Starch	58·67	58·35
Gum	2·53	undet.
Sugar	5·39	"
Soluble albumenoids ..	2·35	"
Insoluble " ..	12·16	"
Total " ..	14·51	13·74
Ash	1·30	1·58
Phosphoric acid.. ..	0·37	0·35
Cellulose	4·06	2·47

(To be continued.)

NOTE ON THE

MOLECULAR VOLUMES OF SOME DOUBLE CHLORIDES.

By R. ROMANIS.

IN a thesis communicated to the University of Edinburgh in 1876, I pointed out certain analogies between the molecular volumes of some hydrated double chlorides, and those of the hydrated magnesian sulphates investigated by Messrs. Playfair and Joule. They found, in the case of the double sulphates with 6 molecules of water, that the volume of the SO_3 of the magnesian sulphate disappears. Thus—

$(NH_4)_2SO_4$	78·4
RO	12·25
$6H_2O$	117·6
	208·25

Here the volume of the hydrated sulphate,—

$(NH_4)_2SO_4.RSO_4.6aq$,

is made up of the volume of the $(NH_4)_2SO_4$ + the volume of the oxide RO + the water as ice.

If we compare the volumes of the chlorides—

$RPtCl_6+6H_2O$,

we find that, like those of the double sulphates, they range from 200 to 215, and the volume may be considered to be made up thus:—

Average volume of the chlorides RCl_2	48·6
Vol. of $PtCl_2$	45·0
Vol. of $6H_2O$ as ice	117·6
	211·2

The anhydrous chlorides, $K_2PtCl_6(NH_4)_2PtCl_6$, &c., show some interesting relations. We find in all cases a great contraction. In the case of the ammonium salt, we have the atomic volume 148; the volume of $PtCl_4$ is 114·7; that of $2(NH_4Cl)$ is 71·32; hence a contraction of 38 takes place, equal to twice the volume of Cl in the chlorides of NH_4 and K, as estimated by Kopp. A similar contraction takes place in the case of the platinic chlorides of zinc, cobalt, nickel, &c. In the case of potassium platinic chloride the contraction is much greater, 54·5.

I have lately continued these experiments, and made a few determinations of the specific gravity of other classes of double chlorides. K_2SnCl_6 has the sp. gr. 2·948, and molecular volume 138·6; $(NH_4)_2SnCl_6$ has sp. gr. 2·511, molecular volume 146·1. The contraction in the case of the potassium salt is 52·5; of the ammonium salt 39·8, corresponding very closely with the platinochlorides.

When $PtCl_2.ZnCl_2$ and $SnCl_2$ combine with other chlorides expansion takes place. Thus—

$(NH_4)_2PtCl_4$, sp. gr. 2·84; mol. vol. = 132; the sum of the volumes of $PtCl_2$ and NH_4Cl is 116·8.

$(NH_4)_2ZnCl_4$, sp. gr. 1·77; mol. vol. = 137; sum of $ZnCl_2$ and $2NH_4Cl = 120$.

The molecular volume of K_2SnCl_4 is 136·6.

The double salts derived from tri- and penta-chloride remain to be examined. The specific gravity of none of them is recorded. I have found the specific gravity of the salt $K_3SbCl_62H_2O$ to be 2·42, the molecular volume is 200·8, the contraction 52·6, nearly the same as that of the platinum and tin salts, but, as it is a hydrated salt, it cannot be strictly compared with them; and the molecular volume given by Kopp for $SbCl_3$ was taken at the boiling-point. The number at the ordinary temperature is probably between 80 and 90.

It would be premature to theorise until every class of double chlorides, bromides, iodides, and fluorides has been examined.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

GALLIUM.

GALLIUM has been so recently discovered, and obtained in such small quantities, that its atomic weight has not as yet been determined with much precision. The following data were fixed by the discoverer, Lecoq de Boisbaudran:†—

3·1044 grms. gallium ammonium alum, upon ignition, left 0·5885 grm. Ga_2O_3.

Hence Ga = 68·071. If O = 16, Ga = 68·233.

0·4481 grm. gallium, converted into nitrate and ignited, gave 0·6024 grm. Ga_2O_3.

Hence Ga = 69·538. If O = 16, Ga = 69·693.

These values, assigned equal weight, give these means:—

If O = 15·9633, Ga = 68·854. If O = 16, Ga = 68·963.

In brief, for all practical purposes, 69 may be assumed as the atomic weight of gallium.

INDIUM.

REICH and Richter, the discoverers of indium, were also the first to determine its atomic weight.‡ They dissolved weighed quantities of the metal in nitric acid, precipitated the solution with ammonia, ignited the precipitate, and ascertained its weight. Two experiments were made, as follows:—

0·5135 grm. indium gave 0·6243 grm. In_2O_3.
0·699 " 0·8515 "

Hence, in mean, In = 110·61, if O = 16; a value known now to be too low.

An unweighed quantity of fresh, moist indium sulphide was also dissolved in nitric acid, yielding, on precipitation,

0·2105 grm. In_2O_3 and 0·542 grm $BaSO_4$.

Hence, with $BaSO_4 = 233$, In = 111·544; also too low.

Soon after the publication of Reich and Richter's paper the subject was taken up by Winkler.‖ He dissolved indium in nitric acid, evaporated to dryness, ignited the residue, and weighed the oxide thus obtained.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Journ. Chem. Soc.*, 1878, p. 646.
‡ *Journ. f. Prakt. Chem.*, 92, 484.
‖ *Ibid.*, 94, 8.

0·5574 grm. In	gave 0·6817 grm. In_2O_3.	
0·6661	„ 0·8144	„
0·5011	„ 0·6126	„

Hence, in mean, if O = 16, In = 107·76; a result even lower than the values already cited.

In a later paper by Winkler* better results were obtained. Two methods were employed. First, metallic indium was placed in a solution of pure, neutral, sodio-auric chloride, and the amount of gold precipitated was weighed. I give the weighings and, in a third column, the amount of indium proportional to 100 parts of gold:—

In.	Au.	Ratio.
0·4471 grm.	0·8205 grm.	57·782
0·8445 „	1·4596 „	57·858
	Mean	57·820 ± 0·026

Hence, if Au = 196·155 ± 0·095, In = 113·417 ± 0·074.

Winkler also repeated his earlier process, converting indium into oxide by solution in nitric acid and ignition of the residue. An additional experiment, the third as given below, was made after the method of Reich and Richter. The third column gives the percentage of In in In_2O_3:—

1·124 grms. In gave	1·3616 grms. In_2O_3.	Per cent, 82·550
1·015 „	1·2291 „	„ 82·581
0·6376 „	0·7725 „	„ 82·537

These figures were confirmed by a single experiment of Bunsen's,† published simultaneously with the specific heat determinations which showed that the oxide of indium was In_2O_3, and not InO as had been previously supposed:—

1·0592 grms. In gave 1·2825 In_2O_3. Per cent In, 82·589

For convenience we may add this figure in with Winkler's series, which gives us a mean percentage of In in In_2O_3 of 82·564 ± 0·0082. Hence, if O = 15·9633, ± 0·0035, In = 113·385 ± 0·060.

Combining results, we have the following general mean:—

From gold series	In =	113·417	± 0·074
„ oxide „	„	113·385	0·060
General mean	„	113·398	0·047

Or, if O = 16, In = 113·659.

NOTE ON PATCHING PLATINUM CRUCIBLES.‡

By H. J. SEAMAN, Catasauqua, Pa.

The author gives his method of avoiding the losses incident to keeping platinum work in repair in laboratories where much fusion work is done. He rubs the crucible and the patch, which should be of stout foil, bright with silica, or rotten-stone, welds a light platinum wire to the corner of the patch, and treats the whole for several hours with hot concentrated hydrochloric acid, washing it then with distilled water, and drying. The head of an ordinary iron rivet is rounded off by hammering, and, after being sunk in a block of hard wood, is used as an anvil. The anvil is then heated to the highest point with a gas blowpipe, fixed in a horizontal position, and when hot, the crucible is dropped on it. The patch is held over the point of operation by means of the thin platinum wire, and a few taps of a light hammer serve to fix it to the crucible. The wire is then nipped off, and the patch firmly united to the crucible by continued tapping, the metal being kept at as nearly a white heat as possible. Mr. Seaman has now three such patched crucibles, one of which has served for at least two hundred fusions, and is still in good order.—*Engineering and Mining Journal.*

§ *Journ. f. Prakt. Chem.*, 102, 282.
† *Poggend. Annal.*, 141, 28.
‡ Read at the Chicago Meeting of the American Institute of Mining Engineers.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 14th, 1884.

Prof. F. Guthrie, President, in the Chair.

New Member:—Mr. Stanley Butler.

Mr. Hoffert read a paper on a new apparatus for colour synthesis, which he exhibited. The colours are obtained by sending through prisms the light from a series of platinum wires made incandescent by Grove or other cells. Three different rays can be compared or superposed at a time by the instrument shown. The rays are received into the eye through an adjustable eye-piece; and various ingenious devices are adopted in the construction of the apparatus. The intensities of the lights are regulated by rheostats in the circuits of the platinum electro-pyres.

Lord Rayleigh, Mr. Stanley, and Prof. Perry commented on the apparatus, and Dr. Guthrie thought that it would be useful in studying colour-blindness.

Mr. Blaikley read a paper on the velocity of sound in small tubes—a continuation of experiments formerly brought before the Society by the author. Mr. Blaikley showed experimentally how his measurements were made. He found that pipes in which the upper proper tones were in harmonic order, or, better still, those in which they were far removed from the harmonic order and therefore dissonant, were best for the purpose. He had obtained velocities from fine tubes varying from 11·4 to 88·2 millimetres in diameter, the former giving 324·38, the latter 330·13 metres per second as the velocity of sound. In free air Mr. Blaikley thought the velocity would come out 331 metres per second. The differences of velocity for the different pipes were very regular.

Lord Rayleigh, Dr. Stone, and Dr. Guthrie made some observations on the paper, Dr. Stone remarking that the diameter of a pipe modified the pitch of the same rate; a fact noticed in musical instruments. In experiments on water waves, Dr. Guthrie had found that in rectangular troughs the rate of oscillation was less than in circular ones.

Mr. Howard read a paper by himself and Mr. Hayward on the "*Thermal Relationship between Water and Certain Salts, such as Sulpho-ethylate, &c.*" Curves of results were given and interpreted.

On Furfurol.—Antony Guyard.—Furfurol is formed whenever a mixture of equal volumes of mono-hydrated sulphuric acid and water, whilst still hot, is thrown upon a matter consisting essentially of a carbohydrate, such as starch, glucose, sugar, saw-dust, filter-paper, &c. The vapours given off are more or less charged with furfurol. The presence of this body can be shown by effecting the reaction in a cylindrical glass, covered with a piece of filter-paper, steeped in aniline acetate. Furfurolic rosaniline is at once developed, the most magnificent but the most fugitive of the aniline reds which it has hitherto been impossible to fix. Furfurol exists in considerable quantity in pyroligneous acid, to which it imparts a bad taste. The author has succeeded in withdrawing the furfurol by shaking up the pyroligneous acid with 20 to 25 c.c. benzol per litre. On standing there are formed two strata,—a layer of benzol from which the furfurol may be separated by distillation, and a watery layer, from which a good vinegar may be obtained by simple distillation.—*Bull. Soc. Chim. de Paris*, No. 6, 1884.

NOTICES OF BOOKS.

A Short Text-Book of Inorganic Chemistry. By Dr. HERMANN KOLBE, Professor of Chemistry in the University of Leipzig. Translated and Edited by T. S. HUMPIDGE, Ph.D., B.Sc., Professor of Chemistry and Physics in the University College of Wales, Aberystwyth. London: Longmans, Green, and Co.

WE are by no means sorry that this work has made its appearance in an English version. Prof. Kolbe is a chemist, not a meta-chemist. He insists on laying a solid foundation of facts for every law and theory, and he discusses the flights of fancy in which some of his contemporaries indulge in a sarcastic spirit. In scientific treatises he insists upon clear, definite ideas expressed in precise, unequivocal language. Hence he is far from popular among the weavers of gossamer hypotheses who do not like to be questioned concerning ths evidence of their assumptions and the exact meaning of their utterances. We need scarcely say that such a writer is needed in the present age.

The author's notion of what a lecturer on chemistry, and, consequently, a writer of an elementary text-book, ought to aim at is "to give his hearers an idea of chemical processes and the most important chemical theories without burdening their memories with a large number of mere facts, and thus to prepare them to acquire an accurate knowledge of chemistry by their own practical work." This is exactly our own opinion.

The author's classification of the elements is different from the traditional arrangement. Tellurium follows upon sulphur and selenium; arsenic and antimony succeed to nitrogen and phosphorus; whilst titanium, molybdenum, tungsten, vanadium, niobium, and tantalum, excluded from the class of metals, are appended to carbon. On the other hand, tin, which Professor Roscoe places among the non-metallic elements, ranks here between bismuth and copper. All the facts prove how obsolete is the division of the simple bodies into metals and non-metals, or as they are grotesquely termed on the Continent, metalloids. The rarer metals are not omitted, but their full study is left to be conducted in the laboratory.

Returning to Professor Kolbe's preface, we find him urging that the chemist cannot learn by reading and hearing, but must see. "A person who, *e.g.*, has not *seen* the phenomena produced by the union of oxygen and hydrogen can have no clear conception of them, nor of the chemical change which accompanies them." He adds:—"Nothing is more foolish than the opinion, which I have often heard from young medical students, that chemistry can be studied from books alone." Singularly enough we came the other day upon a passage in a medical contemporary which shows how many medical students are content with a mere book-knowledge. "One ingenious gentleman, who had somehow learned how to fold a filter-paper, when requested to place it in the funnel, tried to balance it on the orifice of its spout; another could not form the slightest idea what a funnel might be used for. It is far from uncommon to find a funnel in either its simple or self-registering form above comprehension, &c."

Turning from the author to the editor we find that his part has been well performed. He remarks in his preface that "in adapting the book for English students certain alterations and additions were necessary, and to these the author has given his full consent." This sentence may give room for puzzling reflections. Why should a scientific text-book, which is found satisfactory in Germany, require alteration to adapt it for use on our side of the North Sea? It will be difficult to give a really sound answer to this query.

An appendix has been added by Mr. Humpidge containing some useful matter, such as an abstract of the methods followed in determining molecular weights, an account of Prout's law and of the periodic law. Concerning the latter generalisation he remarks that it is "a valuable but still imperfect representation of certain chemical facts, and we must be careful not to accept the values for the atomic weights to which it points, unless confirmed by evidence derived from other sources. It must for the present be still regarded as a hypothesis, until it has been more fully developed, and until the anomalies which it contains have been explained."

We scarcely think that in discussing this law the editor has done full justice to Mr. Newlands.

We note the final sentence in Mr. Humpidge's preface:—"The range which the book covers is rather more than that required for the Intermediate Science and Preliminary Science Examinations of the London University, and the needs of students working for these examinations have been steadily kept in view, but without following the syllabus in a servile manner." In the original, as in German text-books in general, there is no reference to the examinations at any University. The student there is supposed to be working in order to know, not to pass. And the fact that he does know, and that we are obliged to import him to fill positions in this country, ought to convince us that our system is not the best.

The Health of the Senses. By H. MACNAUGHTON JONES, M.D., &c. London: Longmans, Green, and Co.

WE have here a very instructive and at the same time decidedly readable book, calculated to be of great public service. The author gives plain, intelligible directions for preserving the organs of the senses in a state of efficiency, and is insensibly led to considerations on the general health, especially of the nerve-centres. The teachings of this work turn of course mainly upon anatomical and physiological questions, and, of course, do not fall exactly within the ordinary scope of the CHEMICAL NEWS.

The introductory chapter on "preventive medicine" is exceedingly suggestive. The author shows the difficulty of impressing the general public with the importance of sanitary truths so long as the principles of physiology form no integral part of education. But he adds, too truthfully:—"The physiological laboratory and class may rather produce bad effects if the laws there taught and demonstrated are being daily broken by absurd school practices and rules which are framed rather for the ill-health than the health of the young. The thought may be encouraged that physiological precepts may be broken with impunity and a carelessness of attention to them engendered in after life."

The precautions needful for the preservation of sight are well worth attention,—the more as in some respects they run counter to popular prejudice. We are glad to find that he condemns the chimney-pot hat as utterly failing to screen the eye from the glare of sunshine. Dr. Macnaughton Jones is decidedly in favour of the electric light (incandescent) for domestic illumination in preference to gas, and that on the grounds that it gives out less heat and does not flicker. He refers to "the beautiful manner in which Mr. R. Hammond's house at Highgate is lighted by means of electricity."

In the chapter on hearing we find a much-needed caution on the dangerous practice of boxing the ears of children. The care of the skin, as the organ of feeling, naturally leads to certain lessons on cleanliness and on clothing. Tight-lacing and high-heeled boots meet here with a needed exposure. The results of both these follies may be seen illustrated by certain models in view at the Health Exhibition. The liver in the one case and the foot in the other is indeed a sorry sight. But, with the author, and in opposition to Miss Cobbe, we maintain that these malpractices are not due to the caprice of the male sex.

The last chapter is "A Word on Education." The author is an unsparing denouncer of "cram" in all its manifestations. In this respect, we must add, he is fairly

at one with the majority of the heads of the profession who have given the subject a full consideration.

There are very few educated persons who will not be the better for a careful perusal of this little book.

Bulletin of the Philosophical Society of Washington. Vol. IV. Containing the Minutes of the Society from Oct. 9th, 1880, to June 11th, 1881.

This bulletin, though bearing the date 1881, has been long delayed in its appearance.

Among the papers here given is one by Mr. C. Abbe on the altitude of the aurora, a question on which there prevails great difference of opinion. The present methods of measuring the height give only negative results. One method is based on the unproved assumption that the dip of the needle is the same in the upper regions of the air as on the earth's surface.

Prof. Ira Remsen has made on behalf of the National Board of Health an investigation on the organic matter in the air. He finds that air contaminated by being drawn through water containing decaying meat does not yield more than the usual quantity of albumenoid ammonia. On the other hand, air which has been drawn over comparatively dry decaying organic matter yields an abnormally large amount of albumenoid ammonia.

Professors Pumpelly and Smythe find that the removal of bacteria from liquids is very difficult; filtration through many feet of fine sand is not sufficient.

Vol. V., containing the Minutes of the Society from October 8, 1881, to December 16, 1882.

Mr. A. B. Johnson read a paper on the anomalies of sound from fog-signals. The author shows, as the result of a careful official examination, that while there is no lack in the volume of sound emitted by such signals, there is often a decided lack in the hearing of the sound, so much so that it is not heard with the intensity expected, nor at the place expected; it is heard faintly where it ought to be heard loudly, and loudly where it ought to be heard faintly; it is not heard at all at some points, and then further away it is heard better than when near; it is heard and lost, heard and lost again, all within a reasonable ear-shot and while the signal is in full blast.

The annual presidential address was delivered by W. B. Taylor, and was devoted to "Physics and Occult Qualities." The author discussed at great length the dynamic and kinematic theories of force, the theory of molecular kinetics, and the fallacy of kinematic theories. He maintains that force (energy) is "not a metaphorical abstraction; it is not a convenient asylum of ignorance. It is the potency and faculty whereby all inorganic, no less than organic, forms are builded. . . . . To the dynamics of even a single molecule the contestation and constraint of at least two opposite resisting agencies are indispensable. . . . . Nor is the certainty of multiplicity in the slightest degree impaired by our admitted ignorance as to the final number of primeval forces." In this connection he quotes Dr. Lodge, who in a lecture delivered at the London Institution, says: "To the question, what is electricity? we cannot assert that it is a form of matter, neither can we deny it; on the other hand, we certainly cannot assert that it is a form of energy, and I should be disposed to deny it." Professor Silvanus P. Thompson is also quoted as asserting, in his "Elementary Lessons in Electricity," that electricity, whatever it may prove to be, is not matter and is not energy."

Most of the remaining papers in this volume—some of them very important—treat on biological subjects.

Traité Pratique d'Analyses Chimiques et d'Essais Industriels. (Practical Treatise on Chemical Analyses and Industrial Assays.) By Raoul Jagnaux. Paris: Octave Doin.

This book, the author tells us, is designed not for the use of students, but of analysts, metallurgists, and other men of some experience. The majority of the methods given are said to be novel, some having been devised by the author's father, M. Hautefeuille, and some by the author himself. Among the novelties especial attention is called to the precipitation of copper by means of metallic lead. This method is especially recommended for the separation of copper from zinc, nickel, and cobalt. The author neutralises the acid which has served for dissolving the sample with ammonia, and filters if needful. The filtrate is then acidified with acetic acid, three or four plates of lead are added, and a gentle heat is applied. The lead dissolves and metallic copper is deposited. When the solution has become colourless, or retains merely a green colour, if nickel is present it is boiled for a few minutes aud the capsule is removed from the fire; it is let settle, the clear liquid is then decanted off, and a little water added in order to prevent the copper from becoming oxidised. Any small quantity of copper remaining attached to the plates of lead is removed by friction with the fingers, and the lead is then put into a test-glass, moistened with a little acetic acid, rubbed with a rubbing brush over a capsule, and rinsed with the washing bottle in order to remove every trace of copper. After this operation the brush is washed in the water of the capsule. It is necessary not to heat the original solution immediately after the introduction of the plates of lead, lest the deposit of copper should adhere too strongly. It is therefore allowed to stand for a few minutes before applying heat; it is only when the plates are covered with a red coating that it can be safely heated. The metallic copper thus obtained is put in a test-glass and washed repeatedly with acetic acid and water in order to remove the small quantity of lead which remains attached to the copper. The liquid is decanted through a filter upon which the copper is received; it is then washed with boiling water and dried.

Into the filtrate there is then poured sulphuric acid, which precipitates the lead. It is let settle, filtered, washed, and the filter containing the lead sulphate is thrown away. The liquid is poured into a capsule, sulphuretted hydrogen water is added, and, on boiling, the last traces of copper and of lead are precipitated. The deposit is let settle and the clear liquid is filtered. The precipitated sulphides are placed in a glass with a little nitric acid, stirred up, and the glass is filled with sulphuretted hydrogen water in order to re-precipitate the trace of copper sulphide dissolved by the nitric acid. It is filtered and washed with sulphuretted hydrogen water.

The dry metallic copper (see above) is detached as completely as possible from its filter and placed in a phial. This filter and that containing the lead and copper sulphides is burnt and their ash is added to the copper contained in the phial and treated with dilute nitric acid. When all is dissolved the liquid is decanted into a capsule, mixed with ammonia and ammonium carbonate and boiled. The lead—both that entangled in the metallic copper and that from the sulphide—is precipitated, filtered off, and washed with care. The filtrate is placed in a capsule, acidified with nitric or sulphuric acid, mixed with oxalic acid in crystals, and boiled, when the copper is deposited as an oxalate.

The determination is then completed by the author's first method, which is used when no zinc, nickel, or cobalt is present.

The precipitate of copper oxalate is allowed to settle, the clear liquid is decanted, and the precipitate is received upon a filter. The filtrate and the decanted liquid are poured together and treated with a few drops of sulphuretted hydrogen water, in order to throw down the last traces of copper, boiled, and filtered. The copper oxalate is dried, detached as completely as possible from the filter, put in a small porcelain capsule, and ignited at a very gentle heat. It is thus converted into cupric oxide. The filter containing the sulphide and that from the oxalate are dried and burnt, their ash added to the copper oxide obtained above, and weighed.

But a small portion of the copper oxide is reduced during

the ignition, whence the substance weighed is a mixture. It is therefore placed in a porcelain capsule, mixed with water and a small quantity of sulphuric acid, and heated. The copper oxide dissolves, whilst the metallic copper remains untouched. It is let settle, washed repeatedly, received in a small porcelain capsule, dried, and weighed. Its weight is deducted from the weight obtained above. The remainder multiplied by 0·7982 and added to the small quantity of metallic copper obtained gives the total weight in metallic copper.

This method appears tedious, and there are no confirmatory analyses appended. We can scarcely admit that the greater portion of the processes indicated are, as stated in the preface, novel. Thus the determination of potassium and sodium salts and their separation is performed in the ordinary manner. In alkalimetry the author uses Gay-Lassac's burette, a standard solution of sulphuric acid, and litmus as indicator. For saltpetre the author gives merely the indirect method and the procedures of Riffaut and Pelouze. Baryta is directed to be determined by adding sulphuric acid in excess to the solution and boiling afterwards. Under phosphoric acid we find no mention of the molybdic method. There is an account of the magnesia process and of Joulie's modification of the uranium volumetric method. There are no special instructions for the frequent cases where phosphoric acid, in manures, phosphatic minerals, and soils, occurs along with alumina and iron. Alumina is determined by means of ammonia, with the well-known precautions, but there are no special instructions for its separation from iron until we come to the section on iron-ores. The separation is there directed to be performed by boiling in a silver capsule with caustic alkali in excess.

The separation of cobalt from nickel is effected by potassium nitrite in presence of acetic acid.

The author's chief strength is evidently metallurgy. His book is rich in instructions for the analysis of alloys, furnace products, slags, scoriæ, &c.

Several printing faults may be pointed out with a view to correction in any future edition. Thus we read that vermillion is adulterated with "coaltar," in place of "colcothar." A certain process is to be performed "*à chaux*," instead of "*à chaud*." For *per descensum* we have *per descendum*, &c. A good index would greatly add to the value of this book.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 20, May 19, 1884.

On Bromine-Substitutions.—MM. Berthelot and Werner.—The authors have found an order of compounds produced by substitution which may be formed in the calorimeter without the complication of secondary reactions. These are the bromine derivatives of the phenols. They have accordingly studied the formation-heats of these compounds at great length.

Transformation of Conicine into Propyl-pyridine, and Regeneration of the Conicine.—Dr. A. W. Hofmann.—On distilling conicine hydrochlorate with zinc-powder the author obtained a base which he names *congrine*, $C_8H_{11}N$, and which is ortho-propyl-pyridine. On heating this compound to 280°—300° in a sealed tube with concentrated hydriodic acid, conicine is reproduced.

New Method for Measuring the Intensity of an Electric Current in Absolute Units.—H. Becquerel.—The author has for some years been accustomed to measure the absolute intensity of a magnetic or electro-magnetic field by observing the rotation of the plane of polarisation of the light traversing a body placed in this field. He finds that this method is very easily applicable to the absolute measurement of an electric current.

On a Mercurial Galvanometer.—G. Lippmann.—A mercurial manometer placed under the influence of a magnet constitutes a very simple galvanometer, the indications by which are exactly proportional to the intensity of the current.

Variations of the Physical Properties of Bismuth Placed in a Magnetic Field.—M. Huron.—Dr. Kerr has already shown that a mirror of steel placed between the poles of an electro-magnet turns by a certain angle the plane of polarisation of a normal incident ray when the electro-magnet is animated. The rotation is produced in the inverse direction to that of the current effecting the animation. Bismuth possesses similar properties, as it appears from the author's experiments. The electric resistance of bismuth increases when it is placed in a magnetic field.

Expansion-Coefficients of the Elementary Gases.—J. M. Crafts.—Not adapted for useful abstraction.

Transmission of Sound by Gases.—M. Neyreneuf. The author finds that with coal-gas or with hydrogen sound undergoes a less diminution of intensity than in traversing the same stratum of air. This result is contrary to that shown in Leslie's experiment, but in this latter the vibrations were communicated from a solid body to the gas, and not, as in the present researches, from one gas to another.

Variation of the Indices of Refraction of Quartz under the Influence of Temperature.—H. Dufet.

Determination of Vapour-Densities by Gaseous Displacement under Reduced and Variable Pressure.—These two papers do not admit of useful abstraction.

Action of Potassium Sulphide upon Mercury Sulphide.—A. Ditte.—If precipitated mercury sulphide is placed in a strong cold solution of potassium sulphide a large quantity is dissolved. When the liquid is saturated the excess is transformed into transparent shining white needles, $HgS,KS,7HO$. In a hot solution the metallic sulphide is changed into brilliant golden-yellow plates of HgS,KS,HO.

On the Acid Barium Phosphates.—A. Joly.—The decomposition of barium mono-phosphate by water presents two successive phases. In the first, as the weight of the mono-baric salt goes on increasing in arithmetical progression, the weight of the salt which dissolves undecomposed decreases in geometrical progression. When about half the original salt has been decomposed the phenomenon changes, and there is formed in the liquid a bi-acid salt, the proportion of which increases along with the acidity of the liquid, and which at last remains alone.

Solubility of Salts.—M. Etard.—Not suitable for abridgment.

Ammoniacal Silver Chloride and Iodide in Crystals.—M. Terreil.—These compounds have the respective compositions—$AgCl,2NH_3$ and $AgI,2NH_3$.

An Artificial Pseudomorph of Silica.—A. Gorgen.—The author has obtained silica in the crystalline form of peridote. Its action upon polarised light is when dry that of a bi-refringent crystal, and when immersed in water that of a mono-refringent body.

Analysis of the Mineral Water of Brucourt.—Ch. Cloëz.—The properties of this water depend on ferrous and magnesian salts and on iodides.

The Agricultural Use of Superphosphates.—M. P. P. Dehérain.—The author urges that in order to foretell the action of superphosphates upon a soil, it is not sufficient to determine the total quantity of phosphoric acid. We must also ascertain with what bases it is combined.

Comparative Nitrifying Action of Certain Salts Contained in or added to Vegetable Soil.—M. Pichard.—Taking the nitrifying action of gypsum as 100, that of sodium sulphate is 47·91, that of potassium sulphate 35·78, and that of magnesium carbonate 12·52. The nitrifying power of gypsum explains its useful action on lucerne. The power of the lime salts justifies the ancient practice of marling.

Bulletin de la Société Chimique de Paris.
No. 6, March 20, 1884.

Russian Chemical Society: Proceedings of the Chemical Section of the Russian Congress of Naturalists and Physicians held at Odessa.—Aug. 19th to 31st, 1883.—M. Brauner made a communication on the atomic weights of cerium, didymium, and tellurium. The values found agree better with the periodic system than the numbers as determined by other chemists.

M. Petrieff has studied the isomerism of fumaric and maleic acids and the action of zinc-ethyl upon the neutral ether of fumaric acid.

Session, August 20th.—M. Petrieff read a memoir on a new group of colouring compounds derived from aniline. On submitting aniline hydrochlorate to the action of an aqueous solution of potassium nitrite he obtains a crystalline body, $C_{18}H_{18}N_4$, fusible at 95°, and soluble in several liquids. The salts are decomposed by water. This compound dyes silk and cotton a golden yellow. If melted with aniline hydrochlorate it forms a compound, $C_{30}H_{26}N_4$, which dyes silk and cotton a blue, and another product, probably $C_{24}H_{22}N_4$, which dyes violets. If melted with α-naphthol it gives a light orange body, $C_{28}H_{27}N_4$, and with β-naphthol an orange-red product.

M. Petrieff made also a communication on bone-oils.

M. Albitzky has studied the β-dipropyl-acrylic acid obtained by the acid of sulphuric acid and phosphorus terchloride upon β-dipropyl-ethyleno-lactic acid.

M. Lupatkine has obtained a chlorinised alcohol by causing zinc and allyl-iodide to react upon epichlorhydrine.

M. Chestakoff, in preparing diallyl-carbinol has obtained a product boiling between 207° to 215°, and which appears to be diallyl-carbinol in which an atom of H is replaced by a propyl group.

M. Chatzky has obtained allyl-dimethyl-carbinol in which an atom of hydrogen is replaced by the group C_4H_9 by causing a mixture of allyl-iodide and of primary isobutyl-iodide to react upon acetone in presence of zinc.

M. Melikoff described the result of his researches on the homologues of glycidic acid.

Session, August 22nd.—M. Beketoff communicated the result of his researches on lithium oxide.

M. Ponomareff has studied the action of caustic potassa upon the product obtained by Grimaux on melting urea with parabanic acid.

M. Reoformatsky has obtained a hydrocarbon, C_8H_{14}, on treating allyl-diethyl-carbinol with dilute sulphuric acid.

M. Albitzky has studied the specific refractive energy of the hydrocarbon $C_{12}H_{20}$ obtained by means of allyl-dimethyl-carbinol.

M. P. Alexeeff proposes a new constitutional formula for indigo blue.

Session of August 27th.—M. Glinska explained the results of his researches on magnetic iron oxide in efflorescence and the metamorphosis of minerals containing pyroxenes and olivines.

M. Chechoukoff sent in a memoir on the action of chlorine upon isobutylen.

M. Timofeeff examined the yield of hydrocarbons obtained on causing an alkaline alcoholic solution in excess to react upon the chlorides, bromides, and iodides of the ethylic, propylic, isopropylic, and isobutylic alcohols of trimethyl-carbinol of the amylic alcohol of fermentation, and of dimethyl-ethyl-carbinol.

M. Dieff made a communication on the double decompositions between silver oxide and the haloid salts of sodium in an aqueous solution.

M. Petrieff has studied the action of an alcoholic solution of caustic potassa upon epichlorhydrin.

MM. Petrieff and Okolowitsch have studied the action of sodium amalgam upon phenosic trichlorhydrin.

M. P. Alexeeff has undertaken a series of researches on the azocuminic acid.

Session of August 28th.—M. Tchirikoff has studied the action exerted by the presence of certain mineral substances upon the results of the elementary analysis of coal; the action of carbonic acid upon lead peroxide at high temperatures, which, according to the author, does not yield lead carbonate, and the variations of the weight of coal at high temperatures.

M. Pavloff made a communication on tartaric acid.

M. Kissel read a paper on the nitro-derivatives of the fatty series.

M. Ponomareff has studied the ethers of cyanuric acid and its constitution.

Session of August 29th.—M. Betz has found that the sensitiveness of silver bromide to light is increased by allowing it to crystallise in a solution of pure isinglass, and drying at 10° to 12°.

M. Petrieff has studied the double decompositions of salts and determined the relation of the carbonates of calcium, strontium, barium, zinc, cadmium, lead, and silver to the nitrates of the same metals.

M. Hemilian sent in a communication on diphenyl-paraxylyl-methane and its oxidation products.

M. Harnitzky has studied the action of a mixture of acetylene and carbon monoxide upon a solution of cuprous chloride.

M. Beketoff made a communication on the relation between the dissociation heat, the formation-heat, and the relative weights of the combined atoms.

Meeting, September 15th to 27th.—M. Menschoutkine communicated the following researches made in the laboratory of the University of Kazan:—By M. Albitzky, on the β-dipropyl-acrylic acid obtained in setting out from β-dipropyl-ethyleno-lactic acid. By M. Lopatkine, on the action of allyl iodide and zinc on epichlorhydrin. By M. Chestakoff, on the accessory product obtained in the preparation of diallylcarbinol. By M. Chatzky, mentioned above. By M. Reformatsky, mentioned above. By M. Kanounikoff, on the relation between the specific refractive energy of chemical compounds and their composition.

M. Potilitzine sent in a communication on the velocities of chemical reactions.

M. Zaboudsky made a communication on the hydrated silica obtained with cast-iron.

M. Konovaloff gave certain thermic data on pyrosulphuryl chloride.

M. Alexeeff explained his theory on the nature of solutions.

M. Flavitsky stated his mechanical theory of the reciprocal chemical action of the atoms of the elements.

M. Brauner gave the atomic weight of tellurium as 125, which agrees with the place assigned to it in the periodic system.

MEETINGS FOR THE WEEK

Wednesday, 25th.—Society of Arts, 4. (Anniversary).
—— Geological, 8.
Friday, 27th.—Quekett Microscopical Club, 8.
Saturday, 28th.—Physical, 3.

TO CORRESPONDENTS.

Wm. Younger.—You will probably find the most suitable information in the monthly numbers of *The Sugar Cane*.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1283.

FARMYARD MANURE: A MEDIUM FOR THE DEVELOPMENT OF PARASITIC DISEASES.

By Dr. A. B. GRIFFITHS, F.C.S.,
Membre de la Société Chimique de Paris, Silver and Bronze Medallist in Chemistry, &c.

THIS memoir intends to detail some recent researches on farmyard manure as a medium for the development of certain parasitic diseases. Although this time-honoured manure has been looked upon as one of, if not the best, fertiliser known to the cultivator of the soil, yet I wish to show that it may under certain conditions be the means indirectly of destroying his crops instead of feeding them. I took some fresh excrements of the horse, placed them in a dish, and then added a little distilled water, stirred the mixture round with a glass rod, and examined a drop of the liquor under the microscope. I was unable to discover any organisms, but on allowing the dish with its contents to stand 48 hours exposed to the air, and then examining, microscopically, I found it full of life—rod-like bodies endowed with the power of active movement; whereas 48 hours previously all was quiet in the little drop under the microscope. By this examination I was able to distinguish several forms of *Schizomycestes*, namely, bacteria, bacilli, vibrios, &c. Further than this, these researches show that farmyard manure is a medium in which the *Peronospora infestans* can live to a certain extent, for I have transplanted *Peronospora infestans* from *Solanum tuberosum* (potato), to a quantity of moistened farmyard manure, and kept it in this medium for about two days in a warm place. On examination with the microscope, the mycelia of this parasitic organism had ramified in all directions throughout the little mass of manure. So far I have only been able to see *Peronospora* continue this growth of hyphæ of its life-history, and no further. Although I have spent a large amount of time and labour on this most important investigation, I have been unable to witness the production of conidia-bearing branches and gonidia. In fact, the "parasite" in this medium seems only to continue throwing out hyphæ *ad infinitum*. The remaining part (*i.e.* gamogenesis, and the production of oospores) of the life-history of *Peronospora*, as far as I am capable of judging, up to the present time, seems impossible in this medium, although when oospores are transferred from the potato to a fresh piece of moist farmyard manure, they will, on rising the temperature to about 60° C., "germinate," and throw out hyphæ as already described. From these investigations, which were conducted with the greatest possible care, it will be seen that *Peronospora* can live to a certain extent in other media besides the potato; but, the important bearing of this research is to show that farmyard manure may, under certain conditions and circumstances, become the medium for spreading parasitic diseases amongst our crops. I have shown that the potato disease will grow to a certain extent in farmyard manure, and i oospores of the *Peronospora* are wafted by winds, and ultimately fall into this medium which nourishes them, they are ready to attack our potato crops when placed in the land containing this farmyard manure, which may already be diseased. Although the agriculturist has a kind of reverence for this manure, yet it may be possible that it does more harm than good, and other diseases, common to plants, may thrive well in this medium. It may not be too revolutionary to prophesy that the agriculturist of days to come will turn his back on this time-honoured "plant-food" of his forefathers, and will see the advantages of giving his crops sweeter and better foods to subsist on than this food, which is, according to some chemists, of very little value. Quoting from a recent investigator,—"farmyard manures are *not* sufficient even to restore to the constantly cultivated soils what has been taken out in the crops." Farmyard manure may contain all the ingredients which plants extract from the soil, but it also pleads guilty to containing no less than 95 per cent of carbohydrates, of which some chemists are of the opinion that there is already a superabundance in the soil. Therefore if there are 95 cwts. of useless stuff in every 100 cwts. of the manure, what is the use of running the risk of producing diseases in our crops by applying such a poor food to the land? The Chinese, who are the most admirable agriculturists in the world, attach very little value to the excrements of animals as manures; and M. D'Avéne ("*Biedermann's Centralblatt für Agricultur-chemie*," 1883, 643), has cultivated crops for fourteen years with great success without farmyard manure, employing only artificial manures.

Another argument against the use of farmyard manure is that by its use we are apt to cover our fields and plots of land every year with weeds, for the seeds of weeds are taken up by grazing cattle, and these seeds pass through the alimentary canal undigested along with other waste products; these germinate, and the farmer wonders "where all the weeds come from." It is well known, as Liebig* said years ago, "the fertility of a soil cannot remain unimpaired, unless we replace in it *all* those substances of which it has been deprived" by the growth of the crop. This fertility can be entirely kept up by the judicious use of the numerous artificial manures, for in the words of that celebrated chemist just quoted "plants cannot live unless supplied with certain metallic compounds."

These compounds being the bases of our artificial manures, by their use we do not run the risk of adding a substance to the soil which is a medium for the growth and development to a certain extent of parasitic disease, as is the case when we use farmyard manure.

From these investigations it will be seen that the cultivator of the soil has been encouraging disease, if not directly adding it to his land.

I have found that the temperature between 30° and 60° C. is most favourable for the growth of hyphæ of *Peronospora* in farmyard manure. M. Déhérain (*Comptes Rendus*, vol. xcviii., No. 6, Feb. 11, 1884), has shown that marsh-gas is the product of an organised ferment in farmyard manure, and it may be possible that his organised ferment is one of the fungi.

Referring again to the observation already alluded to, namely, that bacteria and other micro-organisms develope in farmyard manure, I have experimented with various mineral compounds which delay or altogether prevent the development of these organisms. It is important, however, to observe that these low forms of life are them selves much more susceptible to these and similar influences than are the spores or germs which seem to resist almost everything. But I have found that there are certain compounds which destroy completely these bacteria. Examining under the microscope a warm infusion of farmyard manure in which there were numerous bacteria growing and multiplying, I found that running in solutions of the following salts completely destroyed the organisms and the spores:—Ferrous sulphate, 0·0269 grm., minimum quantity in 100 grms. of water; cupric sulphate, 0·0073 grm.; and sodium chloride, 5·000 grms., minimum quantities respectively in 100 grms. of water.

As these mineral compounds are all used now as manures, &c., for certain crops, it will be seen that they are useful not only as direct foods for the plant, but are antiseptic agents completely destroying bacteria in farmyard manure, and it is most probable that they will destroy other parasitic forms which are enemies to our crops. I am aware that the investigations of A. Riche

* "Organic Chemistry in its Applications to Agriculture and Physiology," page, 174.

(*Journal de Pharmacie et de Chemie*, vol. viii., Nov., 1883), have shown that the vitality of one and the same micro-organism varies extremely according to the medium in which it lives. These growths may be killed by the solutions mentioned when growing in the infusion, yet live when treated with the same antiseptic solutions when growing in other media.

Whether these mineral compounds act in any way on the *Peronospora* and other parasitic fungi which destroy our crops, I am unable to say at present, but intend to thoroughly investigate this important problem.

THE PHYSICAL AND CHEMICAL ANALYSIS OF FLOUR.*

By ALBERT R. LEEDS.

(Concluded from page 273.)

During the course of the chemical analyses previously detailed trial was made of the various methods for the analysis of flour heretofore proposed. Attempts were made to substitute direct for indirect determination of several constituents, and at the same time to effect a gain in rapidity of working and in accuracy of results. These attempts have been only in part successful. And inasmuch as the difficulties to be overcome can be best explained in connection with the trials of previous methods, the results of these trials will be stated first.

A. *Cairn's Method* ("*Quantitative Analysis,*" *p.* 255).

"Digest 5 grms. of the flour in 100 c.c. cold water for one or two hours, with frequent stirring, filter through a filter previously exhausted with hydrochloric acid, washed, dried, and weighed; wash with about 100 c.c. cold water. The solution contains:—(1) *albumen*, (2) *gum*, (3) *sugar* and a portion of the soluble salts. The residue contains: —(4) *celluloses*, (5) *starch*, *gluten*, and *fat*."

"*Solution.*—1. Boil, and then filter; the precipitate consists of albumen, Dry at 100°, and weigh.

"The treatment with water, filtration, and precipitation of albumen should be completed on the same day. By keeping the solution hot it may be continued through two days, but this is not advisable."

[These are tedious operations, and of questionable accuracy. Granting that the solution of gum, soluble albumen, and sugar is perfect, nevertheless complete washing by this method is troublesome to effect.]

The precipitation of the albumen on boiling so dilute a solution is also imperfect. In an actual trial, even after concentrating the solution to one-half and boiling, only 37 per cent of the soluble albumen was precipitated. On evaporating to 40 c.c. an additional precipitate of 52 per cent was obtained, and to 15 c.c. a third precipitate of 0·4 per cent. It is not only necessary to collect these precipitates of albumen on weighed filters, but to boil down in tared beaker glasses, because the coagulated albumen attaches itself to the sides of the beaker, and cannot be perfectly detached. These three determinations of soluble albumen required, therefore, nine weighings in all, and the final result was incorrect, falling short of the correct result by 7 per cent of the amount actually present.

The albumen so obtained should be ignited, and its amount of ash deducted.

"2. Evaporate the filtrate from the albumen nearly to dryness, add a large excess of alcohol, warm, and then allow it to cool; filter on a weighed filter; wash with alcohol. Dry at 100° C., and weigh the gum thus obtained."

[Note.—The gum thus precipitated carries down with it some saline matters, and it should be ignited, and the weight of ash deducted.]

* Advance sheets communicated by the author. Reprinted from the *Journal of the American Chemical Society*, vol. vi., No. 3.

"3. Evaporate the alcoholic filtrate from the gum to small bulk, add water, and boil out the alcohol. Concentrate the solution to 50 c.c., and divide into halves. In the first half determine the dextrose directly by copper sulphate solution. In the second half add a few drops of dilute sulphuric acid, boil, neutralise with potassium hydrate, and determine dextrose as before. The excess of dextrose found in the second solution is due to cane-sugar."

"*Residue.*—Wash with a jet from the wash-bottle into a beaker. Then dry the filter with what adheres to it and weigh. This weight, less that of the filter found at the beginning, gives the weight of adhering substance, which must be taken into account in the subsequent determinations."

[Note.—Although the amount left behind is small—in a trial only 0·0815 grm. out of an original weight of 5·3005 grm.—yet this filtration is very tedious, and requires two additional weighings.]

"4. Add to the substance in the beaker 50 times its weight of water, containing one per cent of sulphuric acid, and heat for several hours, until the starch goes into solution, and only light flocculent cellulose is left. Filter and wash until all sulphuric acid is removed, dry at 100° and weigh."

[Note.—All the albumenoids and starch are not carried into solution by this method, and the weight of cellulose so obtained much exceeds the true amount. The excess, as determined in one trial, was five times. The so-called cellulose when submitted to chemical treatment under the microscope was found to have unruptured cells, containing starch granules and undissolved albumenoid bodies.]

"5. To the filtrate from the cellulose, diluted to 400 c.c., add about 30 c.c. concentrated sulphuric acid, and heat on a water-bath at about 95° for several hours, adding water from time to time to keep it up to the original bulk. Digest this until a drop of the solution shows no colouration when heated with diluted iodine solution, and also gives no precipitate with alcohol. When the conversion of the starch into dextrose is complete, neutralise the excess of acid by sodium or potassium hydrate, and determine the glucose with copper sulphate as before."

[Note.—It has been shown by Allihn (*J. pr. Chem.*, xxii., 50), and by Salomon that the conversion effected by means of sulphuric acid is only partial, the former authority stating that under the conditions which usually prevail in starch analyses only 95 per cent of the starch is converted into dextrose. In an experiment in which the results obtained with sulphuric acid were compared with those obtained by means of hydrochloric acid, when used according to Sachse's method (*Chem. Centr.*, 1877, 732), to be given later, I obtained a less discrepant result. Sulphuric acid yielded 98 per cent of the amount as determined by hydrochloric acid.]

"The starch can also be determined in a separate portion by washing a weighed quantity with water, then with ether, and again with water, drying and then making an elementary analysis for carbon. The carbon found is from both starch and cellulose. Deduct the carbon due to cellulose found as above (formula, $C_{12}H_{10}O_{10}$, the same as that of starch), and calculate the rest to starch (44 parts carbon = 100 parts starch)."

[Note.—This method is tedious, difficult of execution, and inaccurate. After washing with water and ether, and drying as directed, a tough horny cake was left in the filter-paper, consisting, in addition to the starch and cellulose, of the insoluble gluten, &c. The physical qualities of this mass were such that it could not be detached from the filter. Even had it been possible to do so, the percentage of one ingredient (the starch) could not have been estimated from a carbon determination, when besides the cellulose, a mixture of at least four substances, such as are present in varying amounts in crude gluten, were undetermined.]

"*Albumenoids.*—Determine the total nitrogen in 1 grm. by combustion with soda-lime, and from this calculate the albumenoids; 15·5 parts N = 100 parts albumenoids. From this deduct the albumen found as above; the difference is gluten."

[Note.—It has already been shown that the percentage of albumen found as above is only a fraction of the amount actually present. The ratio of 15·5 : 100 gives for the nitrogen multiplier 6·45. This is certainly too high. Ritthausen concluded from the results of his elaborate analyses of the wheat albumenoids, that the correct multiplier is 6. Others place it at 6·33, and this number has been employed in making the calculations contained in the present article, except where otherwise stated.]

"*Fat.*—Weigh out 2 or 3 grms., treat with ether, boiling it gently over the water-bath, decant the ether through a filter into a weighed dish, repeat this two or three times, evaporate off the ether, and weigh the fat."

[Note.—This method of fat extraction gives results much too low. As thus determined, the Pillsbury flour contained only 1·02 per cent of fat. When the treatment of ether was continued until no more fat could be extracted, the sample of flour (undried) yielded 1·35 per cent of fat; dried, it yielded 1·31 per cent. These latter results are in accordance with those stated by König ("Nahrungsmittel," p. 559), who recommends that the extraction with ether should be performed on the dried substance rather than on the undried, the latter method usually yielding the higher results. This he attributes, not so much to a decomposition and alteration of the fat, but to a solution in water-holding ether of substances other than fat—such as resin, wax, chlorophyll, &c.].

"*Ash.*—Burn 40 or 50 grms. of the flour in a weighed dish. If there is any difficulty in burning off the carbon, cool and weigh the dish and contents; then extract with hot water, filter through a small filter, avoiding any transfer of the carbonaceous substance to the filter. Dry the dish, and weigh again. The loss represents mineral salts dissolved out. Moisten with nitric acid, add the filter-paper and contents, burn again, cool, and weigh. The weight, less that of the dish, represents the remainder of the ash. The weight of the ash of the small filter-paper may be ignored. The ash may be dissolved in water with a little nitric acid, and analysed as required."

[Note.—This amount of flour appears enormously greater than needed, except it be desired to make an extended analysis of the ash. In an actual trial 22,9435 grm. flour was taken, and burned in a platinum capsule, with a small flame placed somewhat to one side of the dish. The platinum was raised to a red heat only, and contact of a current of heated air with the carbonised mass was favoured by this disposition of the flame. At the end of 8 hours I was surprised to find that the ash was burned perfectly, no carbon remaining.]

An accurate method is given by König ("Nahrungs- und Genussmittel," p. 316 and 561). Ten to twenty grms. of the flour is burned, at first over a small flame, until a black coal remains, and no more smoke is given off. Then the flame is removed, the coal pulverised, and allowed to stand for some hours in the air. On now strongly igniting, a very white ash is quickly obtained, or, if necessary, the exposure to air and ignition may be repeated. This gives the raw ash, which may contain coal, sand, and carbonic anhydride, and is not to be set down as the pure ash or "ash."

To correct for carbonic anhydride, the entire raw ash (from 10 to 20 grms. of substance) is dissolved by hydrochloric acid in a CO_2 apparatus, and its amount subtracted.

The solution so obtained is filtered upon a dried tared filter, repeatedly washed with hot HCl, then with hot Na_2CO_3 and NaHO, in order to remove separated silica, then again with hot water, dried at 100° to 110°, and weighed. This residue of coal and sand is then to be deducted from the raw ash.

König says truly that CO_2 in the ash of pure cereals is too inconsiderable to necessitate a correction for it. If the ash does evolve notable CO_2, it indicates an addition of chalk, magnesite, &c.

In nice questions, involving falsifications of the flour, the above method is advisable. But for ordinary determinations a very simple and rapid method, which is given later, will be found accurate.

(To be continued.)

ON THE USE OF TUBES OF COLOURED GLASS FOR NESSLERISING.*

By A. A. BRENEMAN.

The idea of using the ordinary amber-coloured window glass of different shades to furnish a series of standard tints for use in the Nessler ammonia test, occurred to me several years ago, and a note upon the subject was read at the Boston meeting of the American Association in 1880. Since then I have found, however, that the suggestion was not essentially new, and the method proposed, moreover, that of holding a slip of glass of the desired tint over the mouth of a Nessler test-tube filled to the mark with clear water while the tube containing the unknown quantity of ammonia is held by the side of the test-tube for comparison, is open to objection. The fact that light coming to the eye after passing through the length of the comparison tube is modified by reflection at the surface of the coloured glass, as also the fact that the coloured media in the two tubes have their upper surfaces respectively in different planes and at different distances from the eye, both tend to prevent a satisfactory comparison of the two tints. While these difficulties might be corrected, in part at least, by surrounding each tube with a blackened sheath or case, it has seemed more in accordance with the ordinary method of making the Nessler test and with the principles of colorimetry in general, to introduce the coloured medium below the comparison tube. The light from this coloured medium should be applied in connection with a tube precisely like the comparison tube and filled to the mark with clear water; in no other way can the *quality of illumination*, which is essential to a fair comparison, be obtained. The suitability of glass as the coloured medium is simply a question of securing the proper tints. Its cleanliness, uniformity, and fixity of tint render it far superior to any other substance that could be applied to this purpose. It was mentioned in the note referred to that the tints of commercial amber glass corresponded very well with the higher values needed among the Nessler standards, such for example as the tints given by 1 c.c. of Wanklyn's weak solution of ammonia (1 c.c. = 0·00001 grm. NH_3), but it was found difficult to obtain glass matching the tints given by smaller quantities of ammonia and for values under 0·5 c.c. of the standard solution; no glass of tint sufficiently light could be found. Even "flashed" glass which might be supposd to yield lighter tints than "pot-coloured" glass, is still too dark for the purpose. The manufacture of glass is too costly an operation to permit of experiments being made upon special "batches" of glass made for the purpose, unless some manufacturer could be inspired with a scientific interest in such work, or were given an order large enough to warrant the attempt as a matter of business. Failing in this direction, it occurred to me that a tube made from glass of the proper tint might answer the purpose, and the fact that the bottom of such a tube would be *blown* suggested the means of varying its thickness, and therefore its tint, to any desired extent. Such a tube was found, however, to be unsuitable for comparison with the colour of Nesslerised liquids, because the yellow

* *Journal of the American Chemical Society*, vol. vi., No. 4.

light coming through the sides of the tube increased the colour given to the light coming through the bottom, and even when filled with clear waters the quality of illumination in the two tubes was such as to forbid comparison. The only suitable condition seems to be that in which the light enters the tube through the coloured medium placed at or very near the bottom of the tube. The sides of the tube should be of colourless glass, and the tube filled with clear water as mentioned above. These conditions seem to be best fulfilled by such tubes as are shown here, for which I am indebted to the co-operation of a skilful glass-blower, Mr. William Baetz. A short length of amber glass tubing is fused to a longer piece of colourless tubing to form a tube like those used in Nesslerising. The bottom is flat, and the coloured portion forms about one-fifth of the entire tube. It is a matter of some difficulty to find glass of proper composition to adhere readily to the amber glass, and still more so to extend the coloured part of the cylinder by blowing without altering its diameter. Both results have been fairly accomplished, however, and slight defects shown in these tubes will be removed, no doubt, after practice in making them. It is possible, then, to start with glass tubing of a given shade and to weaken the tint by blowing out the tube until the desired tint is reached. The tube is then closed and flattened at the desired distance from the junction with the colourless glass. In practice I have found it more simple to have a number of such tubes made of various shades below a certain one, and to pick out from these such as corresponded exactly with the different tints given by the Nessler reagent with known quantities of ammonia. It has been my custom for years in using Wanklyn's method of water analysis to distil off 10 c.c. at a trial, using only 100 c.c. of the water to be tested, and all of these tubes have been made of the 10 c.c. size, but the principle is perhaps more easily applicable to larger tubes, because the variations of tints required would be less delicate. For very light shades I have found an amber glass with a barely perceptible olive tint to yield the best results when distended and weakened in colour as described. It should be said, finally, that the junction of the compound tube causes an unavoidable *ringed* appearance in the tube when filled with water, but with a well-made bottom to the tube there is always a clear space within the innermost circle sufficiently large to permit of comparison with the tint of the other tube.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
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CERIUM.

Although cerium was discovered almost at the beginning of the present century, its atomic weight was not properly determined until after the discovery of lanthanum and didymium by Mosander. In 1842 the investigation was undertaken by Beringer,† who employed several methods. His cerium salts, however, were all rose-coloured, and therefore were not wholly free from didymium; and his results are further affected by a negligence on his part to fully describe his analytical processes.

First, a neutral solution of cerium chloride was prepared by dissolving the carbonate in hydrochloric acid. This gave weights of ceroso-ceric oxide and silver chloride as follows. The third column shows the amount of CeO_2 proportional to 100 parts of AgCl:—

CeO_2.	AgCl.	Ratio.
0·5755 grm.	1·419 grms.	40·557
0·6715 ,,	1·6595 ,,	40·464
1·1300 ,,	2·786 ,,	40·560
0·5366 ,,	1·3316 ,,	40·297
		Mean 40·469 ± 0·0415

The analysis of the dry cerium sulphate gave results as follows. In a fourth column I show the amount of CeO_2 proportional to 100 parts of $BaSO_4$:—

Sulphate.	CeO_2.	$BaSO_4$.	Ratio.
1·379 grm.	0·8495 grm.	1·711 grm.	49·649
1·276 ,,	0·7875 ,,	1·580 ,,	49·836
1·246 ,,	0·7690 ,,	1·543 ,,	49·838
1·553 ,,	0·9595 ,,	1·921 ,,	49·948
			Mean 49·819 ± 0·042

Beringer also gives a single analysis of the formate and the results of one conversion of the sulphide into oxide. The figures are, however, not valuable enough to cite.

The foregoing data involve one variation from Beringer's paper. Where I put CeO_2 as found he puts Ce_2O_3. The latter is plainly inadmissible, although the atomic weights calculated from it agree curiously well with some other determinations. For instance, in the chloride series, the assumption of Ce_2O_3 as the formula of the oxide obtained, gives $Ce = 137·749$, while CeO_2 makes $Ce = 141·636$. The former agrees with the results of Wolf, Wing, and others quite fairly; the latter is near the value obtained by Bührig. Obviously, the presence of didymium in the salts analysed should tend to raise rather than to lower the apparent atomic weight of cerium.

Shortly after Beringer, Hermann* published the results of one experiment. 23·532 grms. of anhydrous cerium sulphate gave 29·160 grms. of $BaSO_4$. Hence 100 parts of the sulphate correspond to 123·926 of $BaSO_4$.

In 1848 similar figures were published by Marignac,† who found the following amounts of $BaSO_4$ proportional to 100 of dry cerium sulphate:—

122·68
122·00
122·51

Mean 122·40 ± 0·138

If we give Hermann's single result the weight of one experiment in this series, and combine, we get a mean value of 123·019 ± 0·113.

Still another method was employed by Marignac. A definite mixture was made of solutions of cerium sulphate and barium chloride. To this were added, volumetrically, solutions of each salt successively, until equilibrium was attained. The figures published give maxima and minima for the $BaCl_2$ proportional to each lot of $Ce_2(SO_4)_3$. In another column, using the mean value for $BaCl_2$ in each case, I put the ratio between 100 parts of this salt and the equivalent quantity of sulphate. The latter compound was several times re-crystallised:—

	$Ce_2(SO_4)_3$. Grms.	$BaCl_2$. Grms.	Ratio.
First crystallisation ..	11·011	11·990—12·050	91·606
,, ,, ..	13·194	14·365—14·425	91·657
Second ,, ..	13·961	15·225—15·285	91·518
,, ,, ..	12·627	13·761—13·821	91·559
,, ,, ..	11·915	12·970—13·030	91·654
Third ,, ..	14·888	16·223—16·283	91·602
,, ,, ..	14·113	15·383—15·423	91·755
Fourth ,, ..	13·111	14·270—14·330	91·685
,, ,, ..	13·970	15·223—15·283	91·588
			Mean 91·625 ±0·016

* Smithsonian Miscellaneous Collections. "The Constant of Nature."
† *Ann. Chem. Pharm.*, 42, 134.

* *Journ. f. Prakt. Chem.*, 30, 185. 1843.
† *Arch. des Sci. Phys. et Nat.*, (1), 8, 273. 1848.

Omitting the valueless experiments of Kjerulf,* we come next to the figures published by Bunsen and Jegel† in 1858. From the air-dried sulphate of cerium the metal was precipitated as oxalate, which, ignited, gave CeO_2. In the filtrate from the oxalate the sulphuric acid was estimated as $BaSO_4$:—

Grm.	Grm.	Grm.
1·5726 sulphate gave	0·7899 CeO_2 and	1·6185 $BaSO_4$.
1·6967 ,,	0·8504 ,,	1·7500 ,,

Hence, for 100 parts $BaSO_4$, the CeO_2 is as follows:—

48·804
48·575

Mean 48·689 ± 0·077

One experiment was also made upon the oxalate:—

0·3530 grm. oxalate gave 0·1913 CeO_2 and 0·0506 H_2O.

Hence in the dry salt, we have 63·261 per cent of CeO_2.

In each sample of CeO_2 the excess of oxygen over true Ce_2O_3 was estimated by an iodometric titration; but the data thus obtained need not be further considered.

In two papers by Rammelsberg‡ data are given for the atomic weight of cerium as follows. In the earlier paper cerium sulphate is analysed, the cerium being thrown down by caustic potash, and the acid precipitated from the filtrate as barium sulphate:—

Grm.	Grm.	Grm.
0·413 $Ce_2(SO_4)_3$ gave	0·244 CeO_2 and	0·513 $BaSO_4$.

Hence 100 $BaSO_4$=47·563 CeO_2, a value which may be combined with others, thus; this figure being assigned a weight equal to one experiment in Bunsen's series:—

Beringer	49·819 ±	0·042
Bunsen and Jegel	48·689	0·077
Rammelsberg	47·563	0·108
General mean ..	49·360	0·035

It should be noted here that this mean is somewhat arbitrary, since Bunsen and Rammelsberg's cerium salts were undoubtedly freer from didymium than the material studied by Beringer.

In his later paper Rammelsberg gives these figures concerning cerium oxalate. 100 parts gave 10·43 of carbon and 21·73 of water. Hence the dry salt should yield 48·862 per cent of CO_2, whence Ce=137·83.

In all of the foregoing experiments the ceroso-ceric oxide was somewhat coloured, the tint ranging from one shade to another of light brown according to the amount of didymium present. Still, at the best, a faint colour remained, which was supposed to be characteristic of the oxide itself. In 1868, however, some experiments of Dr. C. Wolf|| were posthumously made public, which went to show that pure ceroso-ceric oxide is white, and that all samples previously studied were contaminated with some other earth, not necessarily didymium, but possibly a new substance, the removal of which tended to lower the apparent atomic weight of cerium very perceptibly.

Cerium sulphate was re-crystallised at least ten times. Even after twenty re-crystallisations it still showed spectroscopic traces of didymium. The water contained in each sample of the salt was cautiously estimated, and the cerium was thrown down by boiling concentrated solutions of oxalic acid. The resulting oxalate was ignited with great care. I deduce from the weighings the percentage of CeO_2 given by the *anhydrous* sulphate:—

Sulphate.	Water.	CeO_2.	Per cent CeO_2.
1·4542 grm.	0·19419 grm.	0·76305 grm.	60·559
1·4104 ,,	0·1898 ,,	0·7377 ,,	60·437
1·35027 ,,	0·1820 ,,	0·70665 ,,	60·487
			Mean 60·494 ± 0·024

* *Ann. Chem. Pharm.*, 87, 12.
† *Ibid.*, 105, 45.
‡ *Poggend. Annal.*, 55, 65; 108, 44.
|| *Amer. Journ. Science and Arts*, (2), 46, 53.

After the foregoing experiments the sulphate was further purified by solution in nitric acid and pouring into a large quantity of boiling water. The precipitate was converted into sulphate and analysed as before:—

Sulphate.	Water.	CeO_2.	Per cent CeO_2.
1·4327 grm.	0·2733 grm.	0·69925 grm.	60·311
1·5056 ,,	0·2775 ,,	0·7405 ,,	60·296
1·44045 ,,	0·2710 ,,	0·7052 ,,	60·300
			Mean 60·302 ± 0·004

From another purification the following weights were obtained:—

1·4684 grm. 0·1880 grm. 0·7717 grm. 60·270 per cent.

A last purification gave a still lower percentage:—

1·3756 grm. 0·1832 grm. 0·7186 grm. 60·265 per cent.

The last oxide was perfectly white, and was spectroscopically free from didymium. In each case the CeO_2 was titrated iodometrically for its excess of oxygen. It will be noticed that in the successive series of determinations the percentage of CeO_2 steadily and strikingly diminishes, to an extent for which no ordinary impurity of didymium can account. The death of Dr. Wolf interrupted the investigation, the results of which were edited and published by Professor F. A. Genth.

The experiments of Wolf seem to have hitherto escaped general notice, except from Wing, who has partially verified them.* This chemist, incidentally to other researches, purified some cerium sulphate after the method of Wolf, and made two similar analyses of it, as follows:—

Sulphate.	Water.	CeO_2.	P. c. CeO_2.
1·2885 grm.	0·1707 grm.	0·6732 grm.	60·225
1·4090 ,,	0·1857 ,,	0·7372 ,,	60·263
			Mean 60·244 ± 0·012

The ceroso-ceric oxide in this case was perfectly white. The cerium oxalate which yielded it was precipitated boiling by a boiling concentrated solution of oxalic acid. The precipitate stood 24 hours before filtering.

We may now combine the results of Wolf and of Wing as follows. The two concordant experiments of Wolf's series three and four may be united, giving a mean of 60·267 ± 0·001:—

Wolf, 1st series	60·494 ±	0·024
,, 2nd ,, ...	60·302	0·004
,, 3rd and fourth series ..	60·267	0·001
Wing	60·244	0·012
General mean ..	60·271	0·001

This mean, the percentage of CeO_2 in the anhydrous sulphate, gives Ce=137·724; or, if O=16, Ce=138·039. This varies widely from the ordinarily accepted value as determined by Buehrig.

In 1875 Buehrig's† paper upon the atomic weight of cerium was issued. He first studied the sulphate, which after eight crystallisations still retained traces of free sulphuric acid. He found furthermore that the salt obstinately retained traces of water, which could not be wholly expelled by heat without partial decomposition of the material. These sources of error probably affect all the previously cited series of experiments; although, in the case of Wolf's work, it is doubtful whether they could have influenced the atomic weight of cerium by more than one or two tenths of a unit. Buehrig also found, as Marignac had earlier shown, that upon precipitation of cerium sulphate with barium chloride the barium sulphate invariably carried down traces of cerium. Furthermore, the ceroso-ceric oxide from the filtrate always contained

* *Am. Journ Sci.*, (2), 49, 358. 1870.
† *Journ. f. Prakt. Chem.*, 120, 222.

barium. For these reasons the sulphate was abandoned, and the atomic weight determinations of Buehrig were made with air-dried oxalate. This salt was placed in a series of platinum boats in a combustion tube behind copper oxide. It was then burned in a stream of pure, dry oxygen, aad the carbonic acid and water were collected after the usual method. Ten experiments were made; in all of them the above named products were estimated, and in five analyses the resulting ceroso-ceric oxide was also weighed. By deducting the water found from the weight of the air-dried oxalate, the weight of the anhydrous oxalate is obtained, and the percentages of its constituents are easily determined. In weighing, the articles weighed were always counterpoised with similar materials. The following weights were found:—

Oxalate.	Water.	CO_2.	CeO_2.
9·8541 grms.	2·1987 grms.	3·6942 grms.	—
9·5368 ,,	2·1269 ,,	3·5752 ,,	—
9·2956 ,,	2·0735 ,,	3·4845 ,,	—
10·0495 ,,	2·2364 ,,	3·7704 ,,	—
10·8249 ,,	2·4145 ,,	4·0586 ,,	—
9·3679 ,,	2·0907 ,,	3·5118 ,,	4·6150 grms.
9·7646 ,,	2·1769 ,,	3·6616 ,,	4·8133 ,,
9·9026 ,,	2·2073 ,,	3·7139 ,,	4·8824 ,,
9·9376 ,,	2·2170 ,,	3·7251 ,,	4·8971 ,,
9·5324 ,,	2·1267 ,,	3·5735 ,,	4·6974 ,,

These figures give us the following percentages for CO_2 and CeO_2 in the anhydrous oxalate:—

CO_2.	CeO_2.
48·256	—
48·249	—
48·248	—
48·257	—
48·257	—
48·258	63·417
48·257	63·436
48·262	63·446
48·249	63·429
48·253	63·430
Mean 48·2546 ± 0·001	63·4316 ± 0·0032

From percentage CO_2 .. Ce = 141·228 ± 0·025
,, CeO_2 .. ,, 141·141 0 020

Obviously the single oxalate experiments of Jegel and of Rammelsberg would exert no appreciable influence upon these mean results. They may therefore be ignored.

In combining all of these data in one general mean, we may begin as usual by tabulating our ratios:

(1). $BaSO_4 : Ce_2(SO_4)_3$: : 100 : 123·019 ± 0·113
(2). $BaSO_4 : CeO_2$: : 100 : 49·360 ± 0·035
(3). $BaCl_2 : Ce_2(SO_4)_3$: : 100 : 91·625 ± 0·016
(4). $AgCl : CeO_2$: : 100 : 40·469 ± 0·0415
(5). P.c. CeO_2 from anhydrous sulphate, 60·271 ± 0·001
(6). ,, ,, ,, oxalate, 63·4316 ± 0·0032
(7). ,, CO_2 ,, ,, 48·2546 ± 0·001

These ratios give us four values for the molecular weight of CeO_2 and two values for $Ce_2(SO_4)_3$:—

From (2)	CeO_2 =	172·218 ±	0·124
,, (4)	,,	173·663	0·179
,, (5)	,,	169·651	0·034
,, (6)	,,	173·068	0·033
General mean ..	,,	171·490	0·023

From (1)	$Ce_2(SO_4)_3$ =	567·234 ±	0·522
,, (3)	,,	570·375	0·165
General mean ..	,,	570·093	0·156

Hence we have three independent values for the atomic weight of cerium, as follows:—

From molecular weight of CeO ..	Ce =	139·563 ±	0·024
,, ,, $Ce_2(SO_4)_3$	,,	141·281	0·083
From ratio (7) CO_2 in oxalate.. ..	,,	141·228	0·025
General mean ..		140·424	0·017

Or, if O = 16, Ce = 140·747.

Buehrig's results alone, both sets combined, give Ce = 141·198 ± 0·020; or, if O = 16, Ce = 141·523.

Wolf and Wing's figures alone make Ce = 137·724; or, if O = 16, Ce = 138·039.

The latter result is subject to the errors pointed out by Buehrig as involved in the use of cerium sulphate; but the ceroso-ceric oxide obtained in the analyses was pure white. Buehrig's ceroso-ceric oxide, on the other hand, was yellow. In neither case was didymium present. All things considered, therefore, it is probable that the lower result is too low and the higher result too high. How near the general mean of all may be to the truth we have no evidence to show. It is clear that new determinations are needed, made with material yielding *white* ceroso-ceric oxide, and with avoidance of the sources of error which Buehrig pointed out.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, June 19, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificate was read for the first time:— L. Ehrmann.

During the evening a ballot was held, and the Scrutators (Drs. Plimpton and Miller) declared the following gentlemen duly elected:—W. Alabaster, H. B. Baker, W. T. Burgess, E. G. B. Barlow, R. D. Courtney, E. J. Caley, M. H. Foye, W. F. Fremersdorff, W. F. Grace, J. Hargreaves, Baron F. von Mueller, E. L. C. Muspratt, F. Nettlefold, A. G. Page, J. Parr, E. H. Rogers, R. S. Stephens, T. Stormouth, R. C. Tresidder, A. J. Watts, J. S. Wells.

Dr. Gladstone then took the chair while the President communicated the substance of a most important and lengthy paper entitled "*On the Magnetic Rotary Polarisation of Chemical Compounds in Relation to their Composition; with observations on the Preparation and Densities of the Bodies Examined,*" by W. H. Perkin, F.R.S. In a preliminary note on this subject, read before the Society about two years ago, it was shown that no definite laws could be expected by the ordinary system of comparing the rotary effect of unit lengths of fluid, and that a comparison of molecular lengths (*i.e.*, such lengths of fluid that the ray of light in passing through them should in all cases traverse the same number of molecules) must be made if any relationship in the rotary effect of various bodies was to become apparent. It was further shown that the rotation due to these molecular lengths may be calculated from observations made on unit lengths by the formula $\frac{r.Mw}{d}$; where r = rotation observed: Mw the molecular weight, and d the density; and that if this number be divided by the number similarly obtained for the standard of comparison (in this case water), the result will be *the molecular coefficient of magnetic rotation*, or, more briefly, the *molecular rotation*. Examples were then given, calculated from original observation as well as from numbers taken from the papers of Becquerel and De la Rive, fully confirming this view, and plainly showing the existence of definite laws governing the magnetic rotary polarisation. These investigations have been continued, and the present communication embodies the results of the careful obser-

vations of about 140 substances belonging to the various classes of the fatty series of organic compounds. From these results it is clear that in a strictly homologous series the introduction of each CH_2 is marked by an increase in the molecular rotation. This constant for CH_2 was found (as the mean of a large number of closely concordant observations) to be 1·023. Each series has, in addition, its own initial or *series constant;* and it was found that when this initial constant has been once determined for a series by the careful observation of one of its members the molecular rotation of any other members may be found by the formula Mol. Rot. $= s + 1{\cdot}023.n$; where s = the initial or series constant, and n the number of carbon atoms in the molecule. It is found, however, that in speaking of homologous series the first, and in most cases the first two, members of the series must be omitted. This agrees with the results obtained by other investigators when dealing with other chemical and physical properties, and it appears as if the influence of the hydrocarbon portion of these substances was to a greater or less extent neutralised by that of the extraneous elements, and that the truly homologous series never commences until there are at least three carbon atoms in the nucleus. Again, isomerism plays an important part; and for the above law to hold good it is necessary that the series should be homologous not only in molecular weight, but also in molecular constitution. Thus, taking as the standard the line formed by the molecular rotation of a series of normal compounds, the numbers obtained for iso and secondary bodies of that series lie above the line, those for tertiary bodies being still higher. In fact, the increase of methyl groups tends to raise the molecular rotation; or, in other words, the more complicated the construction the greater the influence on polarised light. In some cases the influence of isomerism is still more marked—as, for instance, in the case of ethylene and ethylidine compounds, and, in fact, wherever there are two or more non-hydrocarbons radicals or elements present in the compound. In this case the numbers obtained vary both according to the arrangement of the carbon atoms in the nucleus, and also as to the position of the substituting radicals, whether they are on the same carbon atom, or on neighbouring or on more distant ones. This is well shown in the case of the ethers of the dibasic acids of the $C_n H_{2n-2}O_4$ series. The acids being solids could not be examined. The normal series appears here to have the formula $COOEt(CH_2)_n COOEt$, and the first member of the truly homologous series to be succinic or possibly glutaric ether. With the help of the malonic acid derivatives a considerable number of representatives of the lower members of this series were obtained and examined. The four ethers of the formula $C_3H_6(COOEt)_2$ will form good examples of the effect of molecular isomerism in this series. The molecular rotations are ethyl glutarate, 9·403 (calculated from succinate); ethyl pyro-tartrate, 9·347; ethyl ethyl-malonate, 9·272; and ethyl dimethyl-malonate, 9·268. With halogen derivatives of polyvalent radicles these isomeric variations are still more marked, the bromides being especially conspicuous in this respect. Turning to the influence of the successive replacement of hydrogen in a compound—the number of carbon atoms in the nucleus remaining unchanged—by a negative radical, it will at once be seen, from what has been said on the effect of isomerism, that it becomes much more difficult to obtain any *fixed* increment as the cases of possible isomerism are so much increased, and it becomes almost impossible to say which kind of replacement should be considered as constituting the homologous series. This difficulty is much added to by the fact that it is almost impossible to obtain these poly-substituted bodies in sufficient numbers and purity for the determinations; many of the bodies, suitable in other respects, melting at too high a temperature. The abstraction of hydrogen (*i.e.*, the rendering unsaturated) of a compound has a most marked and curious influence on its magnetic rotation, raising it about one unit above the normal line for each diminution of H_2. Thus, propyl-alcohol, 3·769; allyl-alcohol, 4·683—difference, 0·914; and ethyl-propyl-malonate, 10·367; ethyl-allyl-malonate, 11·281. Difference, 0·914. Attempts were made to calculate from the results the rotation values of the elements, but it will be seen, on consideration, that as the isomerism of the molecules plays such a leading part in the determination of molecular rotation, the value of the elements must vary according to their position in the molecule, and that the most that could be obtained would be values varying between certain limits or constants for certain series. It is believed that this variation of molecular rotation, due to molecular isomerism, may prove of great use to chemists in helping to determine the constitution of doubtful bodies. The following are the series constants obtained for a large number of different series:—Paraffins, C_nH_{2n+2}, 0·512; iso-paraffins, 0 625; alcohols, $C_nH_{2n+2}O$, 0·700; iso- and sec.- alcohols, 0·845; oxides, $C_nH_{2n+2}O$, 0·642; iso-oxides, 0·932; aldehyds, $C_nH_{2n}O$, 0·264; iso-aldehyds and ketones, 0·377; acids, $C_nH_{2n}O_2$, 0·393; iso-acids, 0·504; formic ethers, ethyl and above, 0·495; acetic ethers, ethyl and above, 0·370; acetic ethers, iso-positive radicals, 0·483; ethers, methyl, 0·273; ethers, ethyl and above, 0·336; iso-ethers, ethyl and above, 0·449; ethers, succinic series, C_nH_{2n-2}, methyl, 0·093; ethers, succinic series, ethyl, 0·196; ethers, succinic series, iso-positive radicals, 2·432; chlorides, $C_nH_{2n+1}Cl$, 1·988; iso- and sec. chlorides, 2·052; bromides, 3·814; iso- and sec. bromides, 3·902; iodides, 8·006; iso- and sec. iodides, 8·092; ethyl-ethers, oleic series, $C_nH_{2n-2}O_2$, 1·452. All the observations were made for the D line of the spectrum. A lamp was used in which hydrogen was passed over strongly-heated sodium, contained in a piece of iron gas-barrel, and thus the gas becoming impregnated with sodium vapour burnt at the nozzle and gave a very brilliant mono-chromatic flame, the size of which could be varied at pleasure. During this research a large number of careful determinations of densities of pure substances were made, and attention has already been called (CHEMICAL NEWS, xlix., 122), to the relationship which the densities of members of homologous series show to one another, and the curves which are formed both by the densities and coefficients of expansion. The author exhibited the sodium lamp, the pole pieces of the magnet, the tubes, the modified Sprengel tube for taking the densities, &c.

Prof. AYRTON said that, although the paper was eminently chemical, he had, as a practical electrician, listened with much interest. It would be of great importance to determine the magnetic value of the field; it would be difficult as the field was not uniform, but it might easily be made uniform. If it were uniform its strength might be measured in terms of Verdet's constant, and we might convert Perkin's numbers into absolute measurements. This having been done the apparatus might be used to determine the strength of a current in absolute measure. It would be very portable and very convenient if a suitable liquid were chosen; so many seconds rotation of the D line would indicate so many amperes.

Dr. GLAZEBROOK some years ago undertook some researches to determine the magneto-rotary power of solutions of certain salts. He had met with two difficulties—the want of a good sodium flame, and the fact that the differences between solutions of varyiug concentration were so small. A plan somewhat similar to that proposed by Prof. Ayrton for determining the strength of a current had been carried out by Lord Rayleigh. The results were not very satisfactory. Bisulphide of carbon was the liquid employed.

After the thanks of the meeting had been given to Dr. Perkin, the Society adjourned over the summer vacation to Nov. 6th, the following papers, in consequence of the lateness of the hour, being taken as read.

"*On the Effect of High Temperatures on Petroleum Hydrocarbons,*" by Drs. ARMSTRONG and MILLER. In this paper the authors describe the results of their examination of the liquid obtained on compressing oil-gas, such as is made by passing the vapour of petroleum through

highly heated retorts; they point out that their material is in every respect similar to that examined by Faraday in 1825, and in which he discovered benzene. Besides benzene and its homologues the liquid from oil-gas contains hydrocarbons of the ethylene and acetylene series. It is noteworthy that the latter are none of them true homologues of acetylene, as they are incapable of forming metallic compounds analogous to acetylide of copper; they are probably all derivatives of allene, $CH_2.C.CH_2$, the isomer of allylene or methyl-acetylene. From the fractions boiling below benzene, two hydrocarbons of the acetylene series have been isolated, methylallene, $CH_3.CH.C.CH_2$, identical with the crotonylene separated by Caventon from the mixture of hydrocarbons condensed by compression of coal-gas and hexoylene, C_6H_{10}, identical with that described by Schorlemmer. The crystalline tetrabromides of these hydrocarbons have both been obtained in large quantity in a pure condition. As yet it has not been found possible to isolate the intermediate hydrocarbon, C_5H_8. The fractions below benzene contain two olefines, amylene and hexylene. A study of their oxidation products shows that both of these are the normal hydrocarbons, the amylene furnishing an oxidation with permanganate, normal butyric acid, the hexylene being converted into normal valeric acid; in other words, the amylene is normal propyl-ethylene, the hexylene normal butyl-ethylene. In conclusion it is pointed out that this is an extension of the investigation of Thorpe and Young. By heating paraffin under pressure at a comparatively moderate temperature they obtained a mixture, with corresponding olefines of lower (normal) paraffins down to pentane. At the higher temperature of the oil-gas retorts, the paraffins are completely converted into olefines, acetylenes, benzenes, &c. It is not improbable that the benzenes are products in a direct line of the action of heat on the paraffins, and that they are not built up as has been supposed from hydrocarbons of the acetylene series.

"*On the Decomposition of Terpenes by Heat*," by W. A. Tilden. The following are the conclusions arrived at by the author:—When ordinary turpentine oil is exposed to a temperature just short of redness, the greater part of it is transformed in four different ways, viz., into an optically inactive terpene, by polymerisation into a colophene, by resolution into cymene and hydrogen, by splitting up into two molecules of a pentine, C_5H_8. These are probably the immediate changes which it undergoes; the small quantities of other hydrocarbons, which are simultaneously produced, being the result of secondary reactions. The citrenes yield the same pentine as also does terpilene, though less readily. The pentine obtained from the terpenes is identical with isoprene. This pentine is readily polymerised by heat into terpilene. From this easy transformation of $2C_5H_8$ into $C_{10}H_{16}$, and *vice versa*, it appears probable that the molecule of terpilene is composed symmetrically of two halves. The pentine from turpentine or isoprene, as it may now be called, is a lower homologue or isomeric, with a lower homologue of heptine from rosin spirit, which has been shown by Morris to be probably methyl propylallene. As the pentine is polymerisable by heat or by sulphuric acid into a dipentine, so the heptine may be converted into a diheptine. $C_{14}H_{24}$ is a liquid boiling 235° to 240°, which appears to possess all the properties of the terpenes. The author intends to examine this compound to ascertain whether it is entitled to rank as a true homologue of turpentine.

"*A Short Note on the General Law which Govern the Dilatation of Liquids*," P. de Heen.

"*On the Melting-points of Certain Inorganic Substances*," by T. Carnelly and L. T. O'Shea.

"*On Nitrification. Part* III.," by R. Warington.

Case of Isomerism in Chloronitrous Camphor.—P. Cazeneuve.—The isomer obtained is soft, not readily pulverised, and dextro-rotatory. The normal compound is hard, friable, and lævo-rotatory.—*Bull. Soc. Chim.*

NOTICES OF BOOKS.

The Non-Bacillar Nature of Abrus Poison: With Observations on its Chemical and Physiological Properties. By C. J. H. Warden, Professor of Chemistry, Calcutta Medical College, and L. A. Waddell, M.B., Resident Physician, Medical College Hospital, Calcutta. Calcutta: Bengal Secretariat Press, 1884.

The poisonous principle contained in the seeds of the Indian liquorice plant, or "jequirity," of the Brazilians, has been the subject of some amount of discussion and investigation. The nature and mode of action on the animal economy of the active agent contained in these seeds have been but imperfectly studied, although abrus seeds have been used extensively in India for many years for poisoning cattle and frequently for homicidal purposes. A remarkable point about abrus seeds is that, although they may be taken in quantity by the mouth with impunity, and indeed form an article of diet in Egypt, when a small quantity of the powdered seeds is introduced beneath the skin, fatal results ensue; less than two grains of the powder administered in this way to cattle occasion death within 48 hours.

It has long been known that an infusion of abrus seeds excites acute inflammation of the conjunctiva, and Sattler has recently come to the conclusion that this inflammation is an infective disease produced by a bacillus present in the air, which takes on pathogenic qualities when growing in an infusion of abrus seeds. This hypothesis of Sattler's was made the starting point of an investigation by MM. Cornil and Berlioz, on the influence of the bacillus on the organism as a whole, and the startling conclusion they arrived at was that the poisonous action of abrus seeds is due to a specific bacillus—"the bacillus of jequirity,"—derived from the seeds, and developing first in the seat of the injection of the infusion, ultimately taking hold on the whole organism and causing death. M. Cornil has even been led so far by his enthusiasm as to assert as the crowning point of his observations that the subcutaneous injection of a small dose of this poison secures the individual against the effects of a further dose, as Pasteur has shown to be the case far certain forms of infective diseases.

This little pamphlet contains the results of the authors' investigations on the existence of this "bacillus of jequirity seeds," with an account of the chemical properties and physiological action of the poisonous principle contained in these seeds. The preface tells us that the presence of Dr. Koch and the German Cholera Commissioners at the Medical College Hospital enabled the authors of this pamphlet to investigate the bacterial side of the question much more completely than could otherwise have been done, the observations being conducted under the immediate superintendence of Dr. Koch. The conclusions the authors arrive at with regard to the bacterial theory of abrus poison are diametrically opposite to those of MM. Cornil and Berlioz. They found neither bacilli or their spores in the seeds, and but very few in the bodies of poisoned animals; that the intensity of the topical action of abrus seed infusion, like that of chemical irritants, depends upon the concentration of the infusion and number of applications; that the toxic action of unsterilised abrus infusion is not necessarily associated with a generalised bacillar formation; when bacilli are found in the blood, their presence is purely accidental and they are non-pathogenous and non-specific; that the blood of an animal killed by abrus poison is not infective, and that a small dose does not confer immunity against further innoculation.

The chemical examination of abrus seeds did not reveal the presence either of an alkaloid or glucoside; the crystalline acid extracted, named abric acid, was proved conclusively to be practically an inert body. The aqueous extract, heated to the boiling-point, was found to have lost

all its poisonous character, although the dried seeds could be kept at 100° for some time without losing materially their activity. The poisonous principle, called abrin, was extracted by percolating the bruised seeds with cold water and precipitating with alcohol, the fatty and colouring matters being first removed by chloroform and dilute alcohol. From their chemical examination of abrin the authors conclude that it is an albumin, as its composition approximates that of egg and some of the vegetable albumins.

The mode of action of abrin was investigated, but the results obtained still leave the matter in doubt. Although experinents showed that abrin does not possess any of the characteristic properties of the soluble ferments, the authors consider there is some analogy between it and snake poison.

To this interesting toxicological pamphlet a number of appendices are added relating to the botanical characters of *Abrus precatorius*, the therapeutic use of abrus seeds in ophthalmia, and an account of the manner in which the natives of India prepare and employ the seeds in the form of needles called "suis" or "sutaris," for poisoning cattle.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 21, May 26, 1884.

Electric Conductivity of Anhydrous Salts, Liquid and Solid.—M. Fousserau.—The author gives his results in the form of tables. He finds that melted salts are in general better conductors than cold saline solutions. The ratio of the coefficient of friction to the resistance remains constant for each salt.

Thermic Study of the Alkaline Fluo-silicates.—Ch. Truchot.—This memoir is not capable of useful abridgment.

Researches on the Bromised Phenols.—E. Werner.—A thermo-chemical paper. The author has determined the melting heat, the specific heat, and the neutralisation heat of these compounds.

Certain Reactions of Albumen.—E. Grimaux.—Albumen in dilute solution is converted by the action of heat into a body which possesses the properties of the albuminates, closely bordering upon those of caseine. If solutions of albumen containing 1 per cent of dry matter are heated to 90° for some minutes a few flocculi separate, but the clear filtrate does not become turbid on boiling; but by the action of carbonic acid in the cold it gives a gelatinous precipitate, which re-dissolves in a current of air.

Analysis of Arable Soils.—G. Lechartier.—M. Grandeau has shown that oxalic acid destroys the calcareous compounds into which the humic matter of the soil enters. The author therefore thought that ammonium oxalate should dissolve not merely the humic compounds, but the mineral principles which are most readily dissolved and assimilated. This expectation has been verified experimentally. The author introduces into a litre flask 20 grms. of the dried soil, previously ground up with a wooden pestle, and 250 c.c. of a solution containing 10 grms. ammonium oxalate, with an excess of ammonia. To the neck of the flask is fitted an ascending refrigerator, and the liquid is heated to a boil. At the outset there is a tendency to swell up, but the ebullition soon becomes regular, and can be kept up without difficulty for seven to eight hours. The brown solution is filtered off and evaporated to dryness. The ammoniacal salt and the dissolved organic matters are decomposed by heat, and there remains a reddish residue, which is treated with hydrochloric acid. In the solution we determine successively the phosphoric acid, the oxides of iron and aluminium, the lime, magnesia, and potash. To exhaust the action of the ammoniacal salt upon the soil a second operation is necessary. The filter with the undissolved portion of soil is re-introduced into the flask and again treated as above.

Bulletin de la Société Chimique de Paris.
No. 6, March 20, 1884.

Thermic Study of Certain Mercury Oxy-chlorides and Oxy-bromides.—M. G. André.—The formation-heat of the oxy-chlorides increases progressively by about 1 cal., as the basicity of the compound increases by 1 mol. HgO, whether the body has been prepared by the dry or the moist method. The formation-heats of the oxy-bromides are a little smaller than those of the corresponding lead compounds, and likewise than those of the mercury oxy-chlorides of the same formula.

Tetranitrous Ethylene Bromide.—A. Villiers.—A further account of the reactions of this body.

Nitro-derivatives of Ethylene Hydride.—A. Villiers.—The author has studied the reduction derivatives of the potassium compound of tetranitric ethylene bromide. He has examined the results of the reaction of sulphurous acid, sodium amalgam, and zinc, in an alkaline solution, which effect a complete reduction with the formation of ammonia and hydrobromic and hydrocyanic acids. With ammonium hydrosulphate several compounds are obtained, the examination of which is still incomplete.

Bromo Xylenol.—P. Adam.—The author sets out with paraxylenol, which is readily bromised by heating to 160°, withdrawing it from the bath and adding the bromine rapidly.

Reply to the New Reclamation of M. Sestini.—MM. C. Vincent and Delachanal.—A dispute concerning priority in a process for the manufacture of potassium sulpho-carbonate.

Synthesis of Tartaric Glucoside.—Antony Guyard.—The author has obtained this compound by throwing tartaric anhydride in fine power powder into melted glucose until the mixture becomes pasty.

Oxidation and the Determination of Chromium Sesquioxide.—H. Baubigny.—This memoir will be inserted at considerable length.

Action of Chlorine upon the Sulphonic Compounds and upon the Amylic Oxy-chlorides.—W. Spring and C. Winssinger.—Not capable of useful abstraction.

No. 7, April 5, 1884.

Action of Methylene Chloride upon Toluene and Benzine.—C. Friedel and J. M. Crafts.—The authors on treating toluene with methylene chloride in presence of aluminium chloride in a reflux apparatus, obtained at the temperature of 290° a considerable quantity of ditolyl-methane, and then, at a higher temperature, a crystalline hydrocarbon, having the same fusion-point as dimethyl-anthracene. There are also formed, in small quantity, carbides which boil at a higher temperature than xylene, and which seem to be trimethyl-benzols. They have repeated the same experiment with benzine, and have obtained dimethyl-methane and anthracen.

Two Camphol-urethanes of a Physical Isomerism analogous to that of Dextro- and Lævo-tartaric Acids.—A. Haller.—The author gives crystallographic measurements proving that the crystals of lævo-camphol-urethane are the inverse analogues of the corresponding dextro-compound.

Ethyl- and Methyl- Acetyl-cyan-acetate of Ethyl.—A. Held.—The ethyl compound is a colourless liquid, of sp. gr., 0·976 at + 20°, becoming yellowish in a few days,

soluble in alcohol and ether in all proportions, but insoluble in water and in alkaline solutions, a property which distinguishes it from acetyl-cyan-acetic ether. The methyl compound has the spec. gr., 0·996 at + 20°, boils at 90° to 95°, and is also insoluble in water and alkalies.

The Oxidation of Menthol by means of Potassium Permanganate.—G. Arth.—The author obtains a compound, $C_{10}H_{18}O_3$, of an acid character.

A New Reaction of Ethyl Carbamate.—G. Arth.—The author treats ethyl carbamate with an alcoholic solution of potassa. After boiling for a half an hour with a reflux condenser he obtains hard, brilliant, lamellar crystals. A solution of this body evaporated with ammonium sulphate yields urea.

Alkali Manufacture.—G. Scheurer - Kestner.—An account of the two forms of Gay-Lussite (an insoluble compound of lime and soda) formed under different circumstances and containing different proportions of water.

The Action of Air on Solutions of Tannin, and the Determination of Tannins.—Antony Guyard.—This paper will be inserted in full.

The Determination of Ammoniacal Nitrogen in Soils.—Antony Guyard.—The author recommends that in the analysis of a soil there should be stated the ammoniacal nitrogen, as obtained by means of calcium carbonate; the organic nitrogen very easily convertible into ammonia, as found by means of basis magnesium carbonate; the nitrogen easily convertible into ammonia by means of calcined magnesia; the nitrogen convertible into ammonia by means of quick-lime; a second portion of nitrogen convertible into ammonia by using 0·5 to 1 grm. soda to 100 parts of soil, and finally the total organic nitrogen as obtained by combustion with soda-lime.

The Separation and Determination of Lime in Presence of a large excess of Alumina, Magnesia, Ferric Oxide, and Phosphoric Acid.—A. Guyard.—Already inserted.

Russian Chemical Society.—Session, September 15/27, 1883.—M. Solovieff sent in a calculation of the number of the normal saturated hydrocarbons.

M. Sokoloff communicated the results of an analysis of the waters of the Neva during the month of September.

M. Konovaloff read a paper on the thermic effect produced by the mixture of liquids.

M. Alexeef gave some instances of the solutions of two liquids in which the thermic effect may be explained by the change in specific heat.

Part 7 of the 15th volume of the *Journal of the Russian Chemical Society* contains memoirs on pyrosulphuryl chloride, by M. Konovaloff; on the relation between the specific refractive energy of chemical compounds and their composition, by M. Kanonikoff; on the velocities of chemical reactions, by M. Potilitzine; and on the present state of the theory of explosives, by M. Tchelzoff.

Justus Liebig's Annalen der Chemie,
Vol. 222, Part 2.

Contributions to our Knowledge of Molybdenum and Tungsten.—Baron Otto von der Pfordten.—The analytical methods contained in this important paper will be given in full at an early opportunity.

Substituted Benzoic Acids and the Nature of the Hydrogen Atoms in Benzol.—H. Hübner.—Part II. This memoir gives an account of meta-brom-meta-nitro-benzoic acid and its derivatives; of para-brom-benzoic acid, para-chlor-benzoic acid, and their derivatives; and of ortho-chlor-benzoic acid.

Studies on Morphine.—O. Hesse.—The author has investigated the behaviour of morphine with acetic anhydride, propionic anhydride, and methyl iodide; the behaviour of the morphine-methyl compounds with acetic anhydride; the action of methyl iodide upon morphine in presence of bases; the behaviour of methyl morphine (codeine) with acetic and propionic anhydride; the action of methyl iodide upon methyl-morphine; the behaviour of methyl-morphine-methyl-chloride with acetic anhydride; the reaction of the corresponding iodide with bases and of the hydroxide concerned with water; the behaviour of methyl-morphimetine with acetic anhydride and methyl iodide; the action of acetic anhydride upon the α-chloride; the behaviour of the α-iodide with alkali, and the reaction of the β-chloride with acetic anhydride. The author concludes from the results obtained that morphine contains only two atoms of hydrogen, capable of being substituted by radicles of the fatty series. One of the hydroxyles in morphine is more resistant than the other.

On Pseudomorphine.—O. Hesse.—The author proves that both the oxymorphine of Schützenberger and Nadler's alleged new base obtained by the action of cupric oxide-ammonium upon morphine are both simply pseudomorphine. He describes a number of the salts of pseudomorphine and gives an account of the behaviour of this base with acetic anhydride.

Cosmos les Mondes.
No. 17, April 26, 1884.

This number contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Prussian Blue.—(Reply to P. B.)—For an outlet for Prussian blue in quantity, I would say that there is a large amount used in the United States for making barrel paint to be used in oil refineries. In fact, I think the chances in that direction are better than any other.
—Oil Merchant, Cincinnati, O., U.S.A.

TO CORRESPONDENTS.

H. R.—Oxygen is returned to the atmosphere through the influence of vegetation.

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END OF VOLUME XLIX.

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